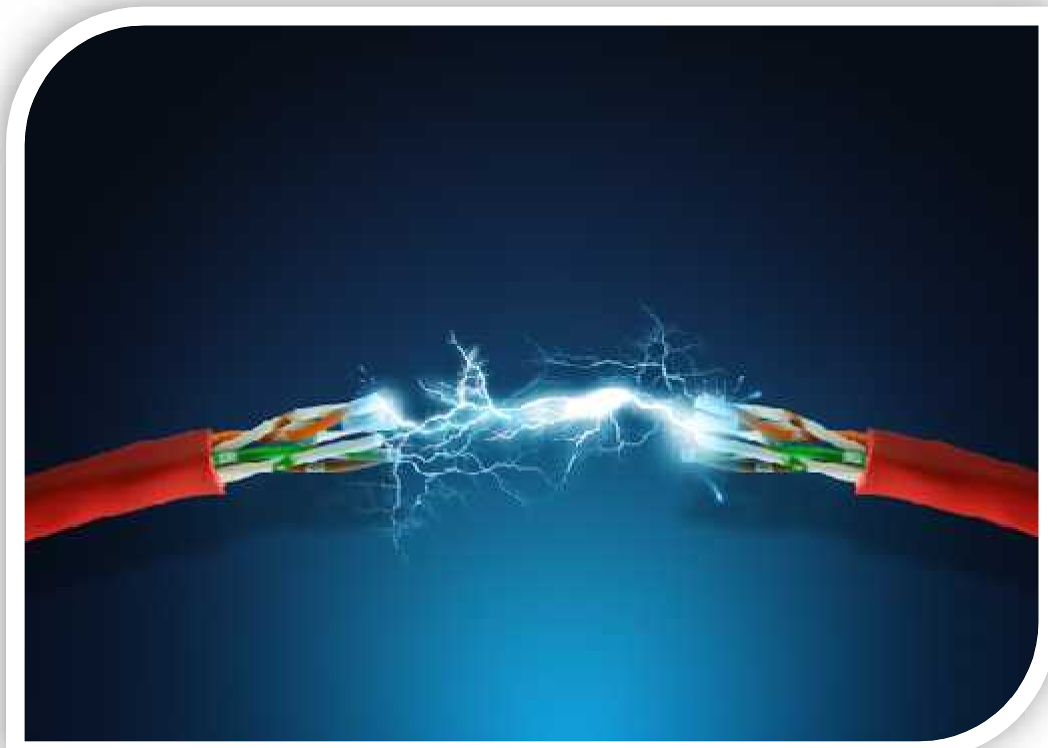
Course 809

Focus Four

Electrocution Hazards



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OSHAcademy Course 809 Study Guide

Focus Four - Electrocution

Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 809.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Course 809

Course Introduction

Welcome to Focus Four-Electrocution Hazards for the construction industry. This is the fourth course covering the hazards described in our Construction Focus Four Hazards series. Please be sure to complete the series by also taking courses 806, 807, and 808. The Focus Four Hazards series was developed in support of the Occupational Safety and Health Administration (OSHA) Construction Outreach Program's effort to help educate workers in the construction industry about:

- understanding the hazards they face; and
- knowing what their employer's responsibilities are to protect workers from workplace hazards.

Construction is among the most dangerous industries in the country and construction inspections comprise 60% of OSHA's total inspections. In 2013, preliminary data from the Bureau of Labor Statistics indicate there were 796 fatal on-the-job injuries to construction workers – more than in any other single industry sector and nearly one out of every five work-related deaths in the U.S. that year. Also in 2013, private industry construction workers had a fatal occupational injury rate almost three times that of all workers in the United States: 9.4 per 100,000 full-time equivalent construction workers versus 3.2 for all workers.

Given current OSHA and industry information regarding construction worksite illnesses, injuries and/or fatalities, students that complete this course will be able to recognize fall hazards, caught-in or-between hazards, struck-by hazards, and electrocution hazards (focus four hazards) employees face in the construction industry.

Students completing the four courses in the Focus Four Hazards series will be able to recognize fall hazards, caught-in or -between hazards, struck-by hazards, and electrocution hazards employees face in the construction industry.

Specifically, once students complete the Focus Four Hazards series they will be able to:

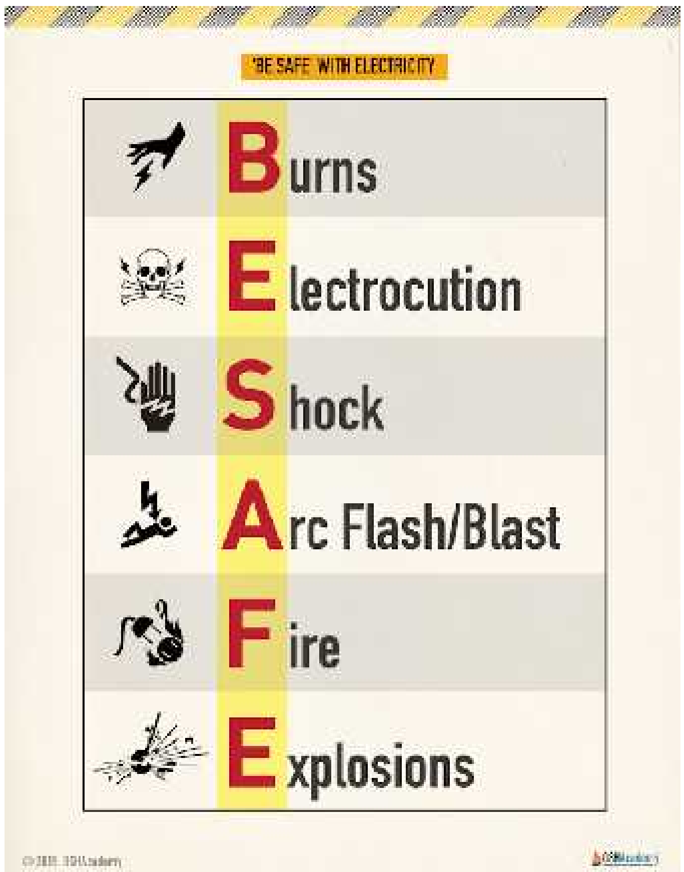
- identify common focus four hazards
- describe types of focus four hazards

- protect themselves from focus four hazards
- recogniz employer requirements to protect workers from focus four hazards

Module 1: What is an Electrocution Hazard?

Definition

Electrocution results when a person is exposed to a lethal amount of electrical energy. An electrical hazard can be defined as a serious workplace hazard that exposes workers to the following:



Therefore, **BE SAFE** by recognizing, avoiding, and protecting against all of these electrical hazards. These **BE SAFE** terms are defined as:

B = Burns

A burn is the most common shock-related injury. Burns from electricity are caused by electrical, arc flash, or thermal contact.

E = Electrocution

Electrocution is fatal; it means to kill with electricity. Electrocution results when a human is exposed to a lethal amount of electrical energy.

S = Shock

Shock results when the body becomes part of the electrical circuit; current enters the body at one point and leaves at another. Electrical shock is defined as a reflex response to the passage of electrical current through the body.

A = Arc Flash/Blast

An arc flash is the sudden release of electrical energy through the air when a high-voltage gap exists, and there is a breakdown between conductors. An arc flash gives off thermal radiation (heat) and bright, intense light that can cause burns. Temperatures have been recorded as high as 35,000 °F. High-voltage arcs can also produce considerable pressure waves by rapidly heating the air and creating a blast.

An arc flash can be spontaneous or result from inadvertently bridging electrical contacts with a conducting object. Other causes may include dropped tools or the buildup of conductive dust or corrosion. For more information on arc flash/blast, including best practices in electrical safety, refer to NFPA 70E: Standard for Electrical Safety in the Workplace®

F = Fire

Most electrical distribution fires result from problems with "fixed wiring" such as faulty electrical outlets and old wiring. Problems with cords (such as extension and appliance cords), plugs, receptacles, and switches also cause electrical fires.

E = Explosions

An explosion can occur when electricity ignites an explosive mixture of material in the air.

Examples

- Two workers were moving an aluminum ladder. The ladder came in contact with the overhead power lines and electrocuted one of the workers.
- When a worker raised the mast on his water well drilling truck, it came into contact with high voltage overhead lines and electrocuted him.
- The boom of a rotary drilling truck contacted an overhead power line and electrocuted the worker. The victim and another worker had just finished drilling a water well on a residential property. The victim moved the truck away from the well. The victim was standing at the controls, lowering the boom and was thrown several feet away from the truck.

- A worker fell to the concrete floor while working from an 8’ fiberglass step ladder. He was fatally injured and electrocuted. The worker was changing an energized ballast on a two bulb fluorescent light fixture, located approximately 11' 6" off the ground.

- A worker was electrocuted while connecting a replacement electrical service box to the electrical service drop to the building.

Statistics

Data from the U.S. Bureau of Labor Statistics, (BLS) show electrocution, was the third leading cause of death in construction in 2013, after falls to a lower level, and being struck by objects and equipment.

Electrocutions caused 8.9% of 796 construction worker deaths in 2013. The death rate from electrocutions for the construction industry was 0.84 per 100,000 full-time workers.

The construction occupations with the highest average number of deaths per year due to electrocution were electricians, construction laborers, supervisors/managers, electrical power installers, and repairers.

Contact with Power Lines

Major Hazards:

Overhead and buried power lines are especially hazardous because they carry extremely high voltage. Fatalities are possible as electrocution is the main risk; however, burns and falls from elevations are also hazards that workers are exposed to while working in the vicinity of high voltage power lines. Workers may not realize that cranes are not the only equipment that reaches overhead power lines. Working on a ladder or in a man-basket suspended under or near power lines also poses a risk of electrocution. Please click here to review toolbox talk 1 in Appendix C

Important to note: The covering on an overhead power line is primarily for weather protection; therefore, workers need to know if they touch a power line, covered or bare, death is likely.

Voltages of overhead lines range from 120 to 750,000 volts. The most reliable way to know the voltage is to ask the utility company that owns the line.

Practice Identifying Hazards

Try to identify the hazards in the picture below. Then continue to the next page to see if you correctly identified the hazards.

Answers: Now, let's take a look at the hazards. Did you correctly identify them?

Let's review examples of actual accidents:

Accident Type:	Electrocution
Weather Conditions:	Wet Ground
Type of Operation:	Remodeling
Size of Work Crew:	2
Collective Bargaining:	No
Competent Safety Monitor on Site:	Yes
Safety and Health Program in Effect:	No
Worksite Inspected Regularly:	Yes
Training and Education Provided:	No
Employee Job Title:	Carpenter
Age & Sex:	33-Male
Experience at this Type of Work:	30 Days
Time on Project:	3 Days

Description of Accident

Two employees were installing aluminum siding on a farmhouse when it became necessary to remove a 36- foot high metal pole CB antenna. One employee stood on a metal pick board between two ladders and unfastened the antenna at the top of the house. The other employee, who was standing on the ground, took the antenna to lay it down in the yard. The antenna made electrical contact with a 7200-volt power transmission line 30 feet 10 inches from the house and 23 feet 9 inches above the ground. The employee handling the antenna received a fatal shock and the other employee a minor shock.

Inspection Results

Following its investigation, OSHA issued one citation for two alleged serious violations of its construction standards. Had these standards been adhered to, the fatality might have been prevented.

What would you recommend?

Recommendations

- Note the presence of power lines and be extremely cautious when working near them. Train employees to recognize and avoid electrical hazards (29CFR 1926.21(b)(2)).
- Do not permit employees to work near any part of an electrical power circuit that might be contacted in the course of the work. Guard all electrical power circuits against accidental contact by insulating the circuit or de-energizing it or by other effective means that would protect the employee (29CFR 1926.400(C)(1)).

Accident Type:	Electrocution
Weather Conditions:	Clear
Type of Operation:	Power Line Work
Size of Work Crew:	2
Collective Bargaining:	Yes
Competent Safety Monitor on Site:	Yes
Safety and Health Program in Effect:	No
Was the Worksite Inspected Regularly:	No

Training and Education Provided:	No
Employee Job Title:	Lineman
Age & Sex:	44-Male
Experience at this Type of Work:	11 Months
Time on Project:	6 Weeks

Description of Accident

A lineman was electrocuted while working on grounded de-energized lines. He was working from a defective basket on an articulated boom aerial lift when the basket contacted energized lines that ran beneath the de-energized lines. The defective basket permitted current to pass through a drain hole cut into the body of the basket, and then through the employee, and to ground via the de-energized line.

Inspection Results

OSHA cited the company for two serious violations and one other-than-serious violation of its construction standards. Had barriers been erected to prevent contact with adjacent energized lines, the electrical shock might have been prevented.

What would you recommend?

Recommendations

1. Guards or barriers must be erected as necessary to adjacent energized lines (29 CFR 1926.950(d)(1)(v)).

2. Existing conditions of mechanical equipment, energized lines, equipment, conditions of poles, and an inspection or test will determine the location of the circuit before starting work. (29 CFR 1926.950(b)(1) and .952(a)(1)).

3. Employees must be instructed on how to recognize and avoid unsafe conditions and on regulations that apply to their work environment (29 CFR 1926.21(b)(2)).

Accident Type:	Electrical Shock
Weather Conditions:	Clear/Hot
Type of Operation:	Masonry Contractor
Size of Work Crew:	6
Collective Bargaining:	No
Competent Safety Monitor on Site:	No
Safety and Health Program in Effect:	Inadequate
Was the Worksite Inspected Regularly:	Yes
Training and Education Provided:	No
Employee Job Title:	Cement Finisher
Age & Sex:	34-Male
Experience at this Type of Work:	10 Years
Time on Project:	1 Day

Description of Accident

Two employees were spreading concrete as it was being delivered by a concrete pumper truck boom. The truck was parked across the street from the worksite. Overhead power lines ran perpendicular to the boom on the pumper truck. One employee was moving the hose (elephant trunk) to pour the concrete when the boom of the pumper truck came in contact with the overhead rover line carrying 7,620 volts. The employee received a fatal electric shock and fell on the other employee who was assisting him. The second employee received massive electrical shock and burns. *Safety training requirement was not being carried out at the time of the accident.

Inspection Results

OSHA cited the employer for not instructing each employee to recognize and avoid unsafe conditions that apply to the work and work areas. The employer was also cited for operating equipment within ten feet of an energized electrical, ungrounded transmission lines rated 50 kV or less and not erecting insulating barriers.

What would you recommend?

Recommendations

1. Train employees to recognize and avoid unsafe conditions that apply to the work environment [28 CFR 1926.21(b)(2)].

2. Avoid operating equipment within ten feet of electrical distribution or transmission lines rated 50 kV or less unless the line has been de-energized and visually grounded, or unless insulating barriers – not part of or attached to the equipment -- are provided [29 CFR 1926.600(a)(6)].

Contact with Energized Sources

Major Hazards:

The major hazards regarding contact with energized sources are electrical shock and burns. Electrical shock occurs when the body becomes part of the electric circuit. This occurs when an individual comes in contact with both wires of an electrical circuit (one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor).

The severity and effects of an electrical shock depend on a number of factors, such as:

- the pathway through the body,
- the amount of current,
- the length of time of the exposure, and
- whether the skin is wet or dry.

Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin. On the next page is a table that discusses the effects of electrical shock.

(1,000 milliamperes= 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)	
Current	**Reaction**
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliampere	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6-25 milliamperes	Painful shock, loss of muscular control
9-30 milliamperes	The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50 - 150 mlliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000 - 4,300	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death likely

Electrical burns can be arc burns, thermal contact burns, or a combination of burns. Electrical burns are among the most serious burns and require immediate medical attention. They occur when an electric current flows through tissue or bone, generating heat that causes tissue damage. The body cannot dissipate the heat generated by current flowing through the resistance of the tissue. Therefore, burns occur.

To further illustrate how easily a person can receive a fatal shock, consider a voltage that is common to every location in the United States, 120-volts. Under average working conditions where a person is perspiring, they have a resistance of only 1000-ohms from hand-to-hand. Using the simple Ohm’s Law formula (current equals the voltage divided by the resistance), the current flow will be 0.12 amperes or 120 mA.

A fault current may travel through a worker's body, causing electrical burns or death if:

- the power supply to the electrical equipment is not grounded, or
- the path has been broken, or

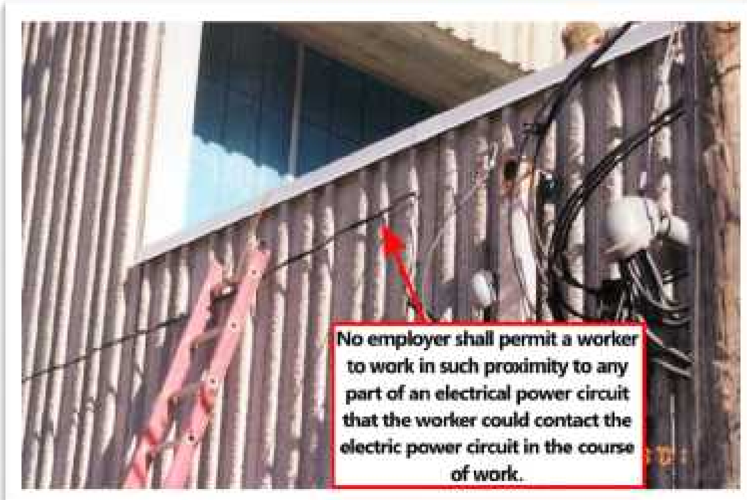
- if there are live parts or bare wires.

Even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment.

Practice Identifying Hazards

Try to identify the hazards in each of the pictures below. Then continue to the next page to see if you correctly identified the hazards.

Answers: Now, let's take a look at the hazards. Did you correctly identify them?



Let's review an example of an actual accident:

Accident Type:	Electrocution
Weather Conditions:	Indoor Work
Type of Operation:	Installing and trouble-shooting overhead lamps
Size of Work Crew:	15
Competent Safety Monitor on Site:	Yes
Safety and Health Program in Effect:	Inadequate
Worksite Inspected Regularly:	Yes
Training and Education Provided:	No
Employee Job Title:	Electrician
Age & Sex:	53-Male
Experience at this Type of Work:	Journeyman
Time on Project:	1 Month

Description of Accident

The employee was attempting to correct an electrical problem involving two non-operational lamps. He proceeded to the area where he thought the problem was. He had not shut off the power at the circuit breaker panel nor had he tested the wires to see if they were live. He was electrocuted when he grabbed the two live wires with his left hand and then fell from the ladder.

Inspection Results

As a result of its investigation, OSHA Issued citations alleging three serious violations. OSHA's construction standards include several requirements that, if they had been followed here, might have prevented this fatality.

What would you recommend?

Recommendations

- The employer should not allow work to be done on electrical circuits unless an effective lock-out/tagout program is implemented [29 CFR 1926.416(a)(1)].
- The employer should not allow work to be done on energized electrical circuits or circuits that are not positively de-energized or tagged out [29 CFR 1926.417(a) and.417(c)].

Improper Use of Extension and Flexible Cords

Major Hazards:

The normal wear and tear on extension and flexible cords can loosen or expose wires, creating a hazardous condition. Cords that are not 3-wire type, not designed for hard-usage, or that have been modified, increase the risk of contacting electrical current. With the wide use of power tools on construction sites, flexible extension cords are often necessary.

Because they are exposed, flexible, and unsecured, they are more susceptible to damage than fixed wiring. Hazards are created when cords, cord connectors, receptacles, and cord- and plug-connected equipment are improperly used and maintained.

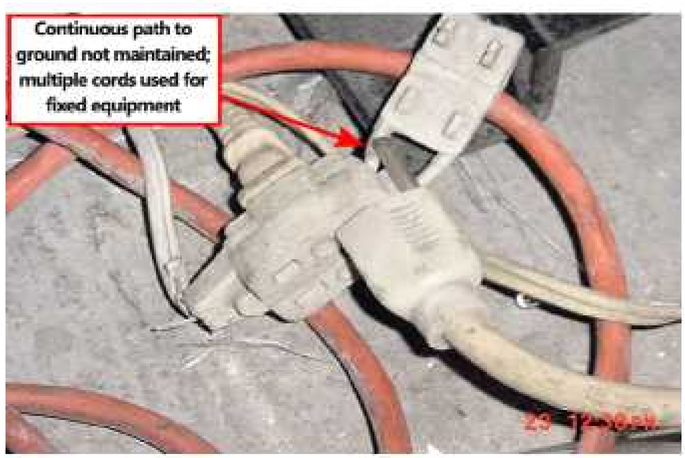
To reduce hazards, flexible cords must connect to devices and fittings in ways that prevent tension at joints and terminal screws. A flexible cord may be damaged by door or window edges, staples and fastenings, abrasion from adjacent materials, or simply by aging. If the electrical conductors become exposed, there is a danger of shocks, burns, or fire.

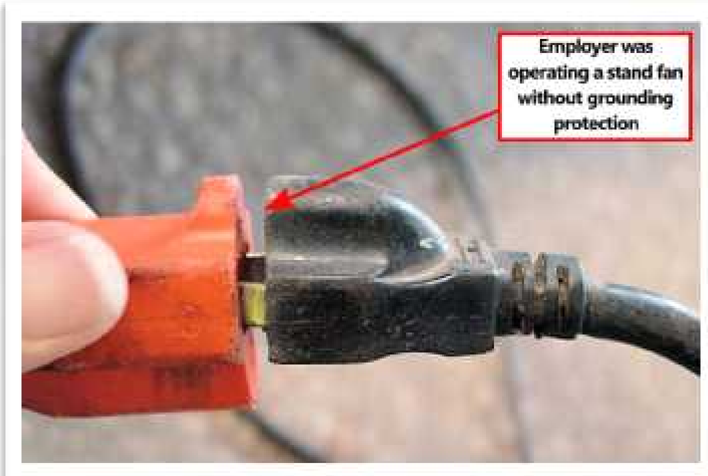
When a cord connector is wet, electric current can leak to the equipment grounding conductor, and to anyone who picks up that connector if they provide a path to ground. Such leakage can occur not just on the face of the connector, but at any portion that is wet.

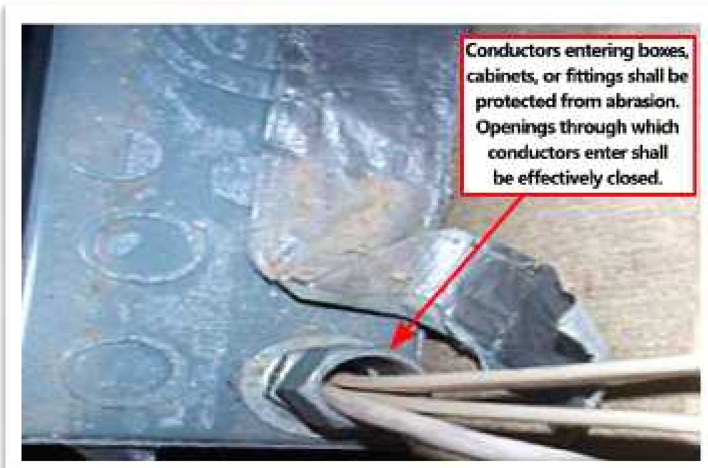
Practice Identifying Hazards

Try to identify the hazards in each picture on the following pages. Then continue to the next page to see if you correctly identified the hazards.

Answers: Now, let's take a look at the hazards. Did you correctly identify them?




Employer was operating a stand fan without grounding protection


Conductors entering boxes, cabinets, or fittings shall be protected from abrasion. Openings through which conductors enter shall be effectively closed.


Flexible cords and cables may pass through doorways or other pinch points if protection is provided to avoid damage.

Let's review an example of an actual accident:

A fan connected to a 120-volt electrical system via an extension cord provided ventilation for a worker performing a chipping operation from an aluminum stepladder. The insulation on the extension cord was cut through and exposed bare, energized conductors made contact with the ladder. The ground wire was not attached on the male end of the cord's plug. When the energized conductor made contact with the ladder, the path to ground included the worker's body, resulting in death.

What would you recommend?

Recommendation

Though it is possible to properly repair the extension cord, it is always best to replace an extension cord that is damaged. Yes, it may cost a little money to replace the extension cord. However, if you don't replace the extension cord, and it is not repaired properly a life can be lost and the company will be put at risk.

Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Electrocution results when a person is exposed to _____.**

    a. a lethal amount of electrical energy
    b. a de-energized circuit
    c. a properly insulated extension cord
    d. an outlet that has a GFCI built into it

2. **Arc flash temperatures have been recorded as high as _____.**

    a. 35,000° F
    b. 500° F
    c. 15,000° F
    d. 5,000° F

3. **Most electrical distribution fires result from problems with _____.**

    a. careless cigarette use
    b. a lack of a fire response plan
    c. de-energized systems
    d. "fixed wiring" such as faulty electrical outlets and old wiring

4. **An explosion can occur when electricity ignites _____.**

    a. dry particle board
    b. an explosive mixture of material in the air
    c. wood debris in a dumpster
    d. cold, damp, wooden materials

5. Overhead and buried power lines are especially hazardous because _____.

a. they carry extremely high voltage
b. they are so easy to see and identify
c. they are always de-energized when work is being performed
d. they carry a very low voltage

Module 2: Protecting Yourself from Electrocution Hazards

Maintain Safe Distance from Overhead Power Lines

Staying away from power lines is the best option. The following table shows the safe power line clearance distance for various line voltages.

Power Line Clearance Distances

Table A – Minimum Clearance Distances	
Voltage (nominal, kV, alternating current)	Minimum clearance distance (feet)
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000	(As established by the power line owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution)

The following are preventive measures for workers to consider.

General

Before work begins, make sure:

- equipment/activity is located within a safe working distance from power lines;

- the utility company has de-energized and visibly grounded the power lines or installed insulated sleeves on power lines;
- flagged warning lines have been installed to mark horizontal and vertical power line clearance distances; and
- tools and materials used are nonconductive.

Cranes and other high-reaching equipment

Be sure the utility company has confirmed the voltage and, therefore, the safe working distance from the power lines. Also, if applicable and feasible, use a/an: observer; insulated link; boom cage guard; proximity device.

Mobile heavy equipment

If provided, use installed rider posts under power lines to avoid working too close to the power lines.

Ladders

Use nonconductive ladders and be sure to retract them before moving.

Material storage

- Ensure no materials are stored under power lines
- Use caution tape and signs to cordon off area under power lines

Excavations

- Locate and understand the markings the local underground line locator service has marked before digging
- Hand dig within three feet of cable location (be aware that more than one underground cable may be buried in area of locator markings)

Let’s review an example of an actual accident:

Accident Type:	Electrocution
Weather Conditions:	Sunny, Clear
Type of Operation:	Steel Erection
Size of Work Crew:	3
Collective Bargaining:	No
Competent Safety Monitor on Site:	Yes - Victim
Safety and Health Program in Effect:	No
Was the Worksite Inspected Regularly:	Yes
Training and Education Provided:	No
Employee Job Title:	Steel Erector Foreman
Age & Sex:	43-Male
Experience at this Type of Work:	4 Months
Time on Project:	4 Hours

Description of Accident

Employees were moving a steel canopy structure using a "boom crane" truck. The boom cable made contact with a 7200-volt electrical power distribution line electrocuting the operator of the crane; he was the foreman at the site.

Inspection Results

As a result of its investigation OSHA issued citations for four serious violations of its construction standards dealing with training, protective equipment, and working too close to power lines. OSHA's construction safety standards include several requirements that, if they had been followed here might have prevented this fatality.

What would you recommend?

Recommendations

- Develop and maintain a safety and health program to provide guidance for safe operations (29 CFR1926.20(b)(1))

- Instruct each employee on how to recognize and avoid unsafe conditions that apply to the work and work areas (29 CFR 1926.21(b)(2))

- If high voltage lines are not de-energized, visibly grounded, or protected by insulating barriers, equipment operators must maintain a minimum distance of 10 feet between their equipment and the electrical distribution or transmission lines (29 CFR 1926.550(a)(15)(i))

What Must Your Employer do to Protect You?

Before working on overhead power lines, they must be de-energized and grounded by the owner/operator of the lines, or other protective measures must be provided, such as PPE (rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets). Protective measures (such as guarding or insulating the lines) must be designed to prevent contact with the lines.

The three primary methods your employer should control power line hazards are:

1. maintaining a safe distance from lines;

2. having the power company de-energize and ground the power line(s) (have a power company representative at the site); and

3. having the power company install insulated sleeves (also known as “eels”) over power lines.

Your employer should train workers regarding power line hazards and about the available protective measures. Employers need to fully warn workers about what jobs may have electrical hazards, and the measure(s) they will take to control the hazards. Also, workers should be reminded they should always ask questions if they have any doubts about maintaining safe working conditions.

Use Ground-fault Circuit Interrupters (GFCI)

A "GFCI" is a ground fault circuit interrupter designed to protect people from severe and sometimes fatal electrical shock. A GFCI detects ground faults and interrupts the flow of electric current and is designed to protect the worker by limiting the duration of an electrical shock.

A Classic Example of the GFCI at Work

A homeowner is using an old drill with a loose bare wire inside it touching the outer metal housing. With the drill plugged in, the housing is charged with electricity. If it is used outside in the rain and the worker is standing on the ground, there is a path from the hot wire inside the drill through the worker to the ground. If electricity flows from hot to ground through the worker, it could be fatal. The GFCI can sense the current flowing through you because not all the current is flowing from hot to neutral as it expects -- some of it is flowing through the worker to the ground. As soon as the GFCI senses that, it trips the circuit and cuts off the electricity.

Types of GFCI

Receptacle GFCI: Often found on construction work sites, outdoor areas and other locations where damp conditions do or could exist. The receptacle GFCI fits into the standard outlet box and protects users against ground faults when an electrical product is connected to the GFCI protected outlet.

If a light or power tool remains “ON” when the “Test” button is pushed, the GFCI is not working properly or has been incorrectly installed (miswired). If this is the case, a qualified electrician needs to be contacted to properly wire or replace the GFCI device.

These should be tested after installation and once a month by:

- Plug in a test light or power tool and turn “On.”
- Push the “Test” button on the receptacle; the “Test” button should pop up, and the power to the light or tool should be “Off.”
- Push “Reset” to restore power to the outlet.
- If the above steps worked, the GFCI passed the test and is functioning properly; if the GFCI failed the test, remove it from service.

Temporary/portable GFCI: A portable GFCI is an extension cord combined with a GFCI. It adds flexibility in using receptacles that are not protected by GFCls. Extension cords with GFCI protection incorporated should be used when permanent protection is unavailable.

These should be tested prior to each and every use by:

- visually inspecting the device for obvious defects and/or broken parts;
- plugging in a test light/tool to the extension cord;
- pushing the “Reset” button on the GFCI device;
- pushing the “Test” button to verify no voltage at outlet (e.g., the light or tool shuts off); and
- pushing the “Reset” button to verify the power is restored.

Circuit Breaker GFCI: The GFCI circuit breaker controls an entire circuit and is installed as a replacement for a circuit breaker on the main circuit board. Rather than install multiple GFCI outlets, one GFCI circuit breaker can protect the entire circuit. At sites equipped with circuit breakers, this type of GFCI might be installed in a panel box to give protection to selected circuits.

Let’s review an example of an actual accident:

Accident Type:	Electrocution
Weather Conditions:	Clear/Hot/Humid
Type of Operation:	Window Shutter Installers
Size of Work Crew:	2
Collective Bargaining:	N/A
Competent Safety Monitor on Site:	No
Safety and Health Program in Effect:	Partial
Was the Worksite Inspected Regularly:	No
Training and Education Provided:	Some
Employee Job Title:	Helper

Age & Sex: 17-Male

Experience at this Type of Work: One Month

Time on Project: One Month

Description of Accident

One employee was climbing a metal ladder to hand an electric drill to the journeyman installer on a scaffold about five feet above him. When the victim reached the third rung from the bottom of the ladder, he received an electric shock that killed him. The investigation revealed that the extension cord had a missing grounding prong and that a conductor on the green grounding wire was making intermittent contact with the energizing black wire thereby energizing the entire length of the grounding wire and the drill's frame. The drill was not double insulated.

Inspection Results

As a result of its investigation, OSHA issued citations for violations of construction standards.

What would you recommend?

Circuit breaker GFCIs should be tested monthly. Keep in mind that the test will disconnect power to everything on the circuit.

Recommendations

- Use approved ground fault circuit interrupters (GFCI) or an assured equipment grounding conductor program to protect employees on construction sites [29 CFR 1926.404(b)(1)].
- Use equipment that provides a permanent and continuous path from circuits, equipment, structures, conduit or enclosures to ground [29 CFR 1926.404(d)(6)].

- Inspect electrical tools and equipment daily and remove damaged or defective equipment from use until it is repaired [29 CFR 1926.404(b)(iii)(c)].

What Must Your Employer do to Protect You?

OSHA ground-fault protection rules and regulations have been determined necessary and appropriate for worker safety and health. It is your employer's responsibility to provide either:

- GFCI’s on construction sites for receptacle outlets in use and not part of the permanent wiring of the structure; or
- a scheduled and recorded assured equipment grounding conductor program on construction sites.

GFCI’s must protect receptacles on the ends of extension cords. Also, an employer may use GFCI circuit breakers. These protected circuit breakers are installed on the main circuit board. GFCI circuit breakers protect an entire circuit.

GFCIs monitor the current-to-the load for leakage to ground. When this leakage exceeds 5 mA ± 1 mA, the GFCI interrupts the current. They are rated to trip quickly enough to prevent electrocution.

Assured Equipment Grounding Conductor Program (AEGCP)

The AEGCP covers 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 that are available for use or used by employees. OSHA requires a written description of the employer's AEGCP, including the specific procedures adopted, be kept at the job site. This program should outline the employer's specific procedures for the required equipment inspections, tests, and test schedule.

The required tests must be recorded, and the record maintained until replaced by a more current record. The written program description and the recorded tests must be made available, at the job site, to OSHA and any affected employee upon request. The employer is required to designate one or more competent persons to implement the program.

Electrical equipment noted in the AEGCP must be visually inspected for damage or defects before each day's use. The employee must not use any damaged or defective equipment until it is repaired.

OSHA requires two tests:

1. **Continuity Test**: The continuity test ensures that the equipment grounding conductor is electrically continuous. Perform this test on all cord sets, receptacles that are not part of a building or structure's permanent wiring, and cord- and plug-connected equipment required to be grounded. This test can be accomplished with various test equipment.

2. **Terminal Connection Test**: The terminal connection test ensures that the equipment grounding conductor is connected to its proper terminal at receptacles and cord plugs. Perform this test with the same equipment used in the first test, or for receptacles use receptacle testers.

Inspect Portable Tools and Extension Cords

Workers need to inspect extension cords prior to their use for any cuts or abrasion. Extension cords may have damaged insulation. Sometimes the insulation inside an electrical tool or appliance is damaged. When the insulation is damaged, exposed metal parts may become energized if a live wire inside touches them. Electric hand tools that are old, damaged, or misused may have damaged insulation inside. Please click here to review toolbox talk 2 and 3 in Appendix C.

Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage. They shall be marked with usage type designation size and number of conductors. The cord could be marked with a 14/3 meaning the conductor size (AWG) is 14, and the number of conductors is 3.

Wire Size and Ampacity

In terms of conducting electrical current, size matters (the size of the electrical conductor). Take a look at the following table regarding *ampacity,* the current-carrying capacity of a conductor in amps. You'll notice two things: the **amount of current** a wire can safely carry **increases** as the **diameter** (and area) of the wire increases and as the number of the **wire size decreases**.

AWG Copper Wire Table

Copper Wire Size (AWG)	Diameter (Mils)	Area (Circular mils)	Ampacity in Free Air	Ampacity as Part of 3-conductor Cable
14 AWG	64.1	4109	20 Amps	15 Amps
12 AWG	80.8	6529	25 Amps	20 Amps
10 AWG	101.9	10,384	40 Amps	30 Amps
8 AWG	128.5	16,512	70 Amps	50 Amps

Notice that a #8 wire is ***twice the diameter,*** but ***four times the area*** of a #14 wire. There are a couple of practical applications here. For one thing, the gauge of the wire determines the rating of a fuse or circuit breaker in amps. A circuit wired with #14 copper will get a 15 amp circuit breaker. A circuit with #12 copper can get a 20 amp breaker; #10 copper can be 30 amps, and so on.

It is also possible to create a fire hazard by *overloading an extension cord.* This occurs when too much current is flowing in a conductor that is not heavy enough for the electrical load in amps. A circuit can be properly wired, and its circuit breaker correctly rated, but if too much current flows through an extension cord with wires that are too small, the cord will heat up. Sometimes there is also a *voltage drop* over a longer extension cord, which could damage your tools.

What must your employer do to protect you?

The OSHA construction standard requires flexible cords to be rated for hard or extra-hard usage. These ratings are derived from the National Electrical Code, and your employer is required to make sure the cord is indelibly marked approximately every foot along the length of the cord. Examples of these codes are S, ST, SO, and STO for hard service, and SJ, SJO, SJT, and SJTO for junior hard service.

Extension cords must be 3-wire type so they may be grounded, and to permit grounding of any tools or equipment connected to them.

Limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors.

Use Power Tools and Equipment as Designed

Workers using power tools and equipment should follow tool safety tips to avoid misusing equipment.

- Never carry a tool by the cord.
- Never yank the cord to disconnect it.
- Keep cords away from heat, oil, and sharp edges.
- Disconnect when not in use and when changing accessories such as blades and bits.
- Avoid accidental starting (do not hold fingers on the switch button while carrying a plugged-in tool).
- Use gloves and appropriate footwear.
- Store tools in a dry place when not using.
- Don't use tools in wet/damp environments.
- Keep working areas well lit.
- Ensure cords do not cause a tripping hazard.
- Remove damaged tools from use.
- Use double-insulated tools.

Common Examples of Misused Equipment

- using multi-receptacle boxes designed to be mounted by fitting them with a power cord and placing them on the floor
- fabricating extension cords with ROMEX wire
- using equipment outdoors that is labeled for use only in dry, indoor locations
- attaching ungrounded, two-prong adapter plugs to three-prong cords and tools

- using circuit breakers or fuses with the wrong rating for over-current protection (e.g., using a 30-amp breaker in a system with 15 or 20 amp receptacles -- protection is lost because it will not trip when the system's load has been exceeded)
- using modified cords or tools (i.e., ground prongs removed, face plates, insulation, etc.)
- using cords or tools with worn insulation or exposed wires

Workers need to know even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment.

What Must Your Employer do to Protect You?

Your employer needs to ensure all power tools and equipment are maintained in a safe condition to:

- ground power supply systems, electrical circuits, and electrical equipment
- frequently inspect electrical systems to ensure path to ground is continuous
- ensure workers understand to inspect electrical equipment prior to use
- ensure ground prongs are not removed from tools or extension cords
- ground exposed metal parts of equipment

Follow Lockout/Tagout Procedures

Lockout/tagout is an essential safety procedure to protect workers from injury while working on or near electrical circuits and equipment. In addition, lockout/tagout prevents contact with operating equipment parts such as blades, gears, shafts, etc. Also, lockout/tagout prevents the unexpected release of hazardous gases, fluids, or solid matter in areas where workers are present.

To protect against being electrocuted, workers need to follow lockout/tagout procedures. If performing lockout/tagout on circuits and equipment, you may use the following checklist.

- Identify all sources of electrical energy for the equipment or circuits in question.
- Disable backup energy sources such as generators and batteries.

- Identify all shut-offs for each energy source.
- Notify all personnel equipment and circuitry must be shut off, locked out, and tagged out (simply turning a switch off is not enough).
- Shut off energy sources and lock switch gear in the OFF position. Each worker should apply his/her individual lock and keys kept with the worker.
- A qualified person must test equipment and circuitry to make sure they are de-energized.
- Deplete stored energy (for example, in capacitors) by bleeding, blocking, grounding, etc.
- Apply a lock or tag to alert other workers that an energy source or piece of equipment has been locked or tagged out.
- Make sure all workers are safe and accounted for before equipment and circuits are unlocked and turned back on. Only a qualified person may determine when it is safe to re-energize circuits.

Only qualified persons may work on electric circuit parts or equipment that has not been de-energized. Such persons must be capable of working safely on energized circuits and must be familiar with the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools.

What Must Your Employer do to Protect You?

Your employer must enforce LOTO safety-related work practices by ensuring:

• controls that are to be deactivated during the course of work on energized or de-energized equipment or circuits are locked out, tagged or both;

• equipment or circuits that are de-energized shall be rendered inoperative and post tags attached at all points where such equipment or circuits can be energized;

• tags are placed to plainly identify the equipment or circuits being worked on; and

• all circuits used to energize equipment are locked out/tagged out if any worker is exposed to contact with parts of fixed electric equipment that has been de-energized.

Let's review an example of an actual accident:

Accident Type:	Electrocution
Weather Conditions:	Raining
Type of Operation:	Electrical Contractor
Size of Work Crew:	2
Collective Bargaining:	No
Competent Safety Monitor on Site:	Yes
Safety and Health Program in Effect:	Inadequate
Was the Worksite Inspected Regularly:	Yes
Training and Education Provided:	No
Employee Job Title:	Journeyman Electrician
Age & Sex:	39-Male
Experience at this Type of Work:	16 Years
Time on Project:	1 Day

Description of Accident

An electrician was removing metal fish tape (a fish tape is used to pull wire through a conduit run) from a hole at the base of a metal light pole. The fish tape became energized, electrocuting him.

Inspection Results

As a result of its inspection, OSHA issued a citation for three serious violations of the agency's construction standards. Had requirements for de-energizing energy sources been followed, the electrocution might have been prevented.

What would you recommend?

Recommendations

1. Ensure all circuits are de-energized before beginning work (29 CFR 1926.416(a)(3)).

2. Controls to be deactivated during the course of work on energized or de-energized equipment or circuits must be tagged (29 CFR 1926.417(a)).

3. Employees must be instructed to recognize and avoid unsafe conditions associated with their work (29 CFR 1926.21(b)(2)).

Is There Anything Else My Employer Must do to Protect Me?

Your employer must also ensure equipment is guarded appropriately, electrical parts are isolated appropriately, and that employees are properly trained about electrocution hazards at their worksite.

Isolate Electrical Parts

Electrical parts, conductors entering boxes, cabinets, or fittings are to be protected from abrasion. Openings through which conductors enter are to be effectively closed. Unused openings in cabinets, boxes, and fittings also need to be effectively closed.

All pull boxes, junction boxes, and fittings must have covers. Metal covers need to be grounded. In energized installations, each outlet box needs to 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 rest.

Ensure Proper Guarding

Guarding involves locating or enclosing electrical equipment to ensure workers do not accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where they are accessible only to authorized people qualified to work with/on the equipment. Recommended locations are a:

- room, vault, or similar enclosure;
- balcony, gallery, or elevated platform; or
- site elevated 8 feet or more above the floor.

Sturdy, permanent screens can also serve as effective guards.

Train Employees

Workers need be trained in and familiar with the safety-related work practices that pertain to their respective job assignments. Employers should train their employees to:

- de-energize electric equipment before inspecting or repairing;
- use cords, cables, and electric tools that are in good repair;
- know and understand lockout/tagout recognition and procedures; and
- use appropriate protective equipment.

Let's review an example of an actual accident:

Accident Type:	Electrocution
Weather Conditions:	Sunny/Clear
Type of Operation:	Fence Construction
Size of Work Crew:	5
Collective Bargaining:	No
Competent Safety Monitor on Site:	No
Safety and Health Program in Effect:	Yes
Was the Worksite Inspected Regularly:	No
Training and Education Provided:	No
Employee Job Title:	Laborer
Age & Sex:	25-Male
Experience at this Type of Work:	3 Months
Time on Project:	1 Day

Description of Accident

Five employees were constructing a chain link fence in front of a house and directly below a 7200-volt energized power line. They were installing 21-foot sections of metal top rail on the fence. One employee picked up a 21-foot section of top rail and held it up vertically. The top rail contacted the 7200-volt line, and the employee was electrocuted.

Inspection Results

Following its inspection, OSHA determined the employee who was killed had never received any safety training from his employer nor any specific instruction in avoiding the hazards posed by overhead power lines. The agency issued two serious citations for the training deficiencies.

What would you recommend?

Recommendations

1. Employers must instruct employees to recognize and avoid unsafe conditions applicable to their work environment [29 CFR 1926.21(b)(2)].

2. Employers must not permit employees to work in proximity to any part of an electrical power circuit when the employee could contact it during the course of work, unless the employee is protected against electric shock by de-energizing the circuit and grounding it or by guarding it effectively by insulation or other means [29 CFR 1910.416(a)(1)].

Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **A ground fault circuit interrupter (GFCI) _____.**

    a. detects ground faults and interrupts the flow of electric current, and is designed to protect the worker by limiting the duration of an electrical shock
    b. detects ground faults and interrupts the electric source thus, it disables the equipment that is attached; however, the worker is still exposed to electrocution
    c. is a tool used to determine if a power system is properly grounded
    d. is a backup energy source that switches on if the power is interrupted

2. **To protect yourself from being electrocuted by contact with overhead power lines, you should always keep yourself and equipment at least ____ away from power lines up to 50kV.**

    a. 5 feet
    b. 8 feet
    c. 10 feet
    d. 15 feet

3. **When a power system is properly grounded, workers need to be aware that _____.**

    a. it is a safe system and cannot change from safe to hazardous; therefore working with electrical equipment is always safe
    b. electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment
    c. the system will remain safe and will not be impacted by changing worksite conditions or electrical equipment
    d. the system may be impacted by changing worksite conditions or electrical equipment, but it’s nothing to be concerned about

4. _____ involves locating or enclosing electrical equipment to ensure workers do not accidentally come into contact with its live parts.

a. Elimination
b. De-energizing
c. Grounding
d. Guarding

5. To protect their employees, employers must ensure extension cords are _____ so they may be grounded.

a. 2-wire type
b. 3-wire type
c. 4-wire type
d. 5-wire type

General Rules for Construction Electrical Safety

MAJOR PROTECTIVE METHODS FROM ELECTRICAL HAZARDS

Protection from electrical hazards generally includes the following methods:

1. **DISTANCE:** Commonly used with regard to power lines.
2. **ISOLATION AND GUARDING:** Restricting access, commonly used with high voltage power distribution equipment.
3. **ENCLOSURE OF ELECTRICAL PARTS:** A major concept of electrical wiring in general, e.g., all connections are made in a box.
4. **GROUNDING:** Required for all non-current carrying exposed metal parts, unless isolated or guarded as above. (However, corded tools may be either *grounded* **OR** be *double-insulated*.)
5. **INSULATION:** Intact insulation allows safe handling of everyday electrical equipment, including corded tools. Category also includes insulated mats and sleeves.
6. **DE-ENERGIZING AND GROUNDING:** Protective method used by electrical utilities and also in conjunction with electrical lockout/tagout.
7. **PERSONAL PROTECTIVE EQUIPMENT (PPE):** Using insulated gloves and other apparel to work on energized equipment, limited to qualified and trained personnel working under very limited circumstances.

Effects of Electric Current in the Human Body

Current / Reaction *(1,000 milliamperes = 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)*
Below 1 milliampere Generally not perceptible
1 milliampere Faint tingle **5 milliampere** Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6-25 milliamperes (women) Painful shock, loss of muscular control
9-30 milliamperes (men) The freezing current or " let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50-150 milliamperes Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000 - 4,300 milliamperes Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes Cardiac arrest, severe burns; death probable

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Construction Focus Four: Electrocution

Safety Tips for Workers

Contents:

- Electrical Safety Overview
- General Rules for Electrical Work
- Condensed Electrical Glossary
- General Rules for Construction Electrical Safety
- Effects of Electric Current in the Human Body

Electrical Safety Overview

1. **CORD AND PLUG OPERATED** electric tools with exposed metal parts must have a *three-prong grounding plug* – AND *be grounded* – or else be *double-insulated.*

2. **EQUIPMENT GROUNDING** *only works when there is a permanent and continuous electrical connection between the metal shell of a tool and the earth.*

3. **PROPER POLARITY IN ELECTRICAL WIRING IS IMPORTANT:** *hot to hot, neutral to neutral, equipment ground to equipment ground. Polarized plugs have a wider neutral blade to maintain correct polarity.* ***Reversed polarity can kill.***

4. **CIRCUITS MUST BE EQUIPPED WITH FUSES OR CIRCUIT BREAKERS** *to protect against dangerous overloads. Fuses melt while circuit breakers trip to turn off current like a switch.* ***Overcurrent protection devices protect wiring and equipment from overheating and fires.*** *They may, or may not, protect you.*

5. **MOST 120 VOLT CIRCUITS** *are wired to deliver up to 15 or 20 amps of current. Currents of* ***50 – 100 milliamperes*** *can kill you. (1 mA = 1/1,000 of 1 Amp.)*

6. **WET CONDITIONS LOWER SKIN RESISTANCE,** *allowing more current to flow through your body. Currents* ***above 75 milliamps*** *can cause* ***ventricular fibrillation,*** *which may be fatal. Severity of a shock depends on: path of current, amount of current, duration of current,* voltage level, moisture and your general health.

7. **A GROUND FAULT CIRCUIT INTERRUPTER** (GFCI) protects from a ground-fault, the most common electrical hazard. GFCIs detect differences in current flow between hot and neutral. They trip when there is current leakage – such as through a person – of about 5 milliamperes and they act within 1/40 of a second. Test a GFCI everytime you use it. It must "Trip" and it must "Reset."

8. **EXTENSION CORD WIRES MUST BE HEAVY ENOUGH** for the amount of current they will carry. For construction, they must be UL approved, have strain relief and a 3-prong grounding plug, be durable, and be rated for hard or extra-hard usage.

9. **OVERHEAD POWER LINES CAN KILL.** The three major methods of protection are: maintaining a *safe distance, de-energizing AND grounding lines,* having the power company install *insulating sleeves.* Have a power company rep on the site.

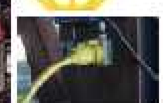
10. **UNDERGROUND POWER LINES CAN KILL.** Call before you dig to locate all underground cables. Hand dig within three feet of cable location!

General Rules for Electrical Work

- ***Non-conductive PPE is essential for electricians. NO METAL PPE! Class B hard hats provide the highest level of protection against electrical hazards, with high-voltage shock and burn protection (up to 20,000 volts). Electrical hazard, safety-toe shoes are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground.***
- ***Be alert to electrical hazards,*** especially when working with ***ladders, scaffolds and other platforms.***
- *Never bypass electrical protective* systems or devices.
- ***Disconnect cord tools*** when not in use and when changing blades, bits or other accessories.
- *Inspect all tools* before use.
- *Use only grounded extension cords.*
- ***Remove damaged*** tools and damaged extension cords from use.
- ***Keep working spaces and walkways clear*** of electrical cords.

RULES FOR TEMPORARY WIRING AND LIGHTING

- *Use Ground Fault Circuit Interrupters (GFCIs)* on all 15-Amp and 20-Amp temporary wiring circuits.
- *Protect temporary lights* from contact and damage.
- ***Don't suspend temporary lights by cords,*** unless the temporary light is so designed.



Condensed Electrical Glossary

AMPERE OR AMP: The unit of electrical *current* (flow of electrons). • One *milliamp (mA)* = 1/1,000 of 1 Amp.

CONDUCTORS: Materials, such as metals, in which electrical current can flow.

ELECTRICAL HAZARDS can result in various effects on the body, including: • SHOCK – The physical effects caused by electric current flowing in the body. • ELECTROCUTION – Electrical shock or related electrical effects resulting in death. • BURNS – Often occurring on the hands, thermal damage to tissue can be caused by the *flow of current* in the body, by *overheating of improper or damaged electrical components,* or by an *arc flash.* • FALLS – A common effect, sometimes caused by the body's reaction to an electrical current. A non-fatal shock may sometimes result in a fatal fall when a person is working on an elevated surface.

EXPOSED LIVE PARTS: Energized electrical components not properly enclosed in a box or otherwise isolated, such that workers can touch them and be shocked or killed. Some of the common hazards include: missing knockouts, unused openings in cabinets and missing covers. Covers must not be removed from wiring or breaker boxes. Any missing covers must be replaced with approved covers.

INSULATORS: Materials with high electrical resistance, so electrical current can't flow.

LOCKOUT/TAGOUT: The common name for an OSHA standard, *"The control of hazardous energy (lockout/tagout)."* ***Lockout*** is a means of controlling energy during repairs and maintenance of equipment, whereby energy sources are *de-energized, isolated,* and then *locked out* to prevent unsafe start-up of equipment which would endanger workers. *Lockout* includes – but is not limited to – the control of electrical energy. ***Tagout*** means the placing of warning tags to alert other workers to the presence of equipment that has been locked out. Tags alone DO NOT LOCK OUT equipment. ***Tagout is most effective when done in addition to lockout.***

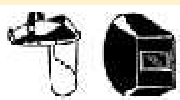
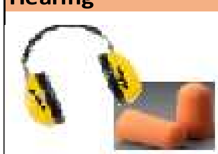
OHM or Ω: The unit of *electrical resistance* (opposition to current flow).

OHM'S LAW: A mathematical expression of the relationship among *voltage* (volts), *current* (amps) and *resistance* (ohms). This is often expressed as: $E = I \times R$. In this case, E = volts, I = amps and R = ohms. (The equation, Amps = Volts/Ohms, as used in this curriculum, is one form of Ohm's Law.)

VOLT: The unit of *electromotive force (emf)* caused by a *difference in electrical charge or electrical potential* between one point and another point. **The presence of voltage is necessary before current can flow in a** *circuit* (in which *current* flows from a *source* to a *load* – the equipment using the electricity – and then back to its source).

WET CONDITIONS: Rain, sweat, standing in a puddle – all will decrease the skin's electrical resistance and increase current flow through the body in the event of a shock. **Have a qualified electrician inspect any electrical equipment that has gotten wet before energizing it.**

Appendix B

PPE for Workers Checklist	
Protection	**Typical Operations of Concern**
Eye 	Sawing, cutting, drilling, sanding, grinding, hammering, chopping, abrasive blasting, punch press operations, pouring, mixing, painting, cleaning, siphoning, dip tank operations, dental and health care services, battery charging, installing fiberglass insulation, compressed air or gas operations, etc.
Face 	Pouring, mixing, painting, cleaning, siphoning, dip tank operations, welding, pouring molten metal, smithing, baking, cooking, drying, cutting, sanding, grinding, hammering, chopping, pouring, mixing, etc.
Head 	Work stations or traffic routes located under catwalks or conveyor belts, construction, trenching, utility work, construction, confined space operations, building maintenance, building maintenance, utility work, construction, wiring; work on or near communications, computer, or other high tech equipment; arc or resistance welding, etc.
Feet 	Construction, plumbing, smithing, building maintenance, trenching, utility work, grass cutting, building maintenance; utility work; construction; wiring; work on or near communications, computer, or other high tech equipment; arc or resistance welding, welding, foundry work, casting, smithing, demolition, explosives manufacturing, grain milling, spray painting, abrasive blasting, work with highly flammable materials, etc.
Hands 	Grinding, sanding, sawing, hammering, material handling, pouring, mixing, painting, cleaning, siphoning, dip tank operations, healthcare and dental services, welding, pouring molten metal, smithing, baking, cooking, drying, building maintenance; utility work; construction; wiring; work on or near communications, computer, or other high tech equipment; arc or resistance welding; etc.
Body 	Pouring, mixing, painting, cleaning, siphoning, dip tank operations, machining, sawing, battery charging, installing fiberglass insulation, compressed air or gas operations, cutting, grinding, sanding, sawing, glazing, material handling, welding, pouring molten metal, smithing, baking, cooking, drying, pouring, mixing, painting, cleaning, siphoning, dip tank operations, etc.
Hearing 	Machining, grinding, sanding, work near conveyors, pneumatic equipment, generators, ventilation fans, motors, punch and brake presses, etc.

Appendix C

Focus Four [Electrocution] Toolbox Talks 1:

What increases your risk of electrocution?

What are the hazards? Bodily contact with electricity

What are the results? Shock, fire, burns, falls or death

What should we look for? Damaged equipment, faulty wiring, improper cord use, no GFCIs, wet conditions, reverse polarity, potential arc flash areas, lack of assured equipment grounding conductor program

Actual Incident: A 40-year-old male plumber died after lying on his work light while installing plumbing under a house being remodeled. The victim was crawling under the house carrying the work light with him. The wire inside the work light's conduit became bare and energized the light's housing. Investigation of the incident showed a damaged work light was used with no GFCI. Also, the home's electrical system was not properly grounded.

How do we prevent these results?

- Inspect all electrical equipment before use.
- Use GFCI with all power tools.
- Use intact and properly rated cords (i.e. correct AWG).
- Do not use damaged equipment - take it out of service.
- Institute an assured equipment grounding conductor program.
- Do not work in wet conditions with electricity.

Let's talk about our work site now.

- What factors increase your chance of being electrocuted?
- Can someone demonstrate how to inspect this tool for electrical safety? (If possible, provide a tool)

- What are some areas on the site that could use attention pertaining to electrical hazards?

[Record questions below that you want to ask about this work site.]

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Focus Four [Electrocution] Toolbox Talks 2:

What protective devices and procedures can you use to prevent electrocution?

What are the hazards? Bodily contact with electricity due to faulty equipment, ungrounded or damaged equipment, wet conditions, etc.

What are the results? Shock, fire, burns, falls or death

What should we look for? Proper training in using engineering controls (e.g. GFCIs, proper cords), assured equipment grounding conductor written program, electrical testing meters

Actual Incident: A 29-year- old male welder was electrocuted and died when he contacted an energized receptacle end of an extension cord. It was found that the welding unit and cord were incompatible; however, both the welding cord and extension cord were damaged allowing them to be used together. The result was an ungrounded system that killed a worker.

How do we prevent these results?

- Inspect all electrical equipment before use.
- Use GFCI with all power tools.
- Use intact and properly-rated cords (i.e. correct AWG).
- Do not use damaged equipment - take it out of service.
- Institute an assured equipment grounding conductor program.
- Use testing meters, where appropriate, if you are trained to do so.

Let’s talk about our worksite now.

- Can someone explain how a GFCI works? (If possible, provide a GFCI to use).
- Who has read this site’s assured equipment grounding conductor program?
- What are some of the requirements?

[Record questions below that you want to ask about this site.]

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Focus Four [Electrocution] Toolbox Talks 3:

How can we prevent electrocutions while using power tools?

What are the hazards? Bodily contact with electricity

What are the results? Shock, fire, burns, falls or death

What should we look for? Tools that aren't double-insulated, damaged tools and cords, incorrect cords, wet conditions, tools used improperly

Actual Incident: A 45-year-old male electrician was electrocuted when he contacted an energized 1/2" electric drill casing. The victim was working in wet conditions and using a single insulated drill attached to damaged extensions cords run through water.

How do we prevent these results?

- Get proper training on manufacturers' tool use and specs.
- Inspect tool before each use according to manufacturers' instructions.
- Do not use damaged tools, remove them from service.
- Use only battery-powered tools in wet conditions.
- Use with GFCI.
- Use with properly sized and intact cords.

Let's talk about our worksite now.

- What can lead to an electrocution while using power tools? Non-double-insulated tools, damaged cord, wet conditions
- Have you seen or used any defective power tool?
- What should you do if you find a defective power tool?

[Record questions below that you want to ask about this site.]

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Glossary

Acceptable: an installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of 29 CFR1926.449 Subpart K:

(a) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a qualified testing laboratory capable of determining the suitability of materials and equipment for installation and use in accordance with this standard; or

(b) With respect to an installation or equipment of a kind which no qualified 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 those provisions; or

(c) 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.

Accepted: an installation is "accepted" if it has been inspected and found to be safe by a qualified testing laboratory.

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: the current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

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.

Approved: acceptable to the authority enforcing 29 CFR 1926.449 Subpart K. 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.

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.

Certified: equipment is "certified" if it:

(a) Has been tested and found by a qualified testing laboratory to meet applicable test standards or to be safe for use in a specified manner, and

(b) Is of a kind whose production is periodically inspected by a qualified testing laboratory. Certified equipment must bear a label, tag, or other record of certification.

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

(b) (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:

(a) **Class I, Division 1**. A Class I, Division 1 location is a location:

(1) In which ignitable concentrations of flammable gases or vapors may exist under normal operating conditions; or

(2) In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or

(3) In which breakdown or faulty operation of equipment or processes might release ignitable 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; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; and all other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(b) **Class I, Division 2**. A Class I, Division 2 location is a location:

(1) 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

(2) In which ignitable 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

(3) That is adjacent to a Class I, Division 1 location, and to which ignitable 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 of 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:

(a) **Class II, Division 1**. A Class II, Division 1 location is a location:

(1) 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

(2) 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

(3) In which combustible dusts of an electrically conductive nature may be present.

NOTE: 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.

(b) **Class II, Division 2**. A Class II, Division 2 location is a location in which:

(1) 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

(2) 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 111 locations include the following:

(a) **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: 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, sawdust, woodchips, and other material of similar nature.

(b) **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: (a) **Bare**. A conductor having no covering or electrical insulation whatsoever.

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

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

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.

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.

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**".

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 § 1926.408(d), 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.

Festoon lighting: a string of outdoor lights suspended between two points more than 15 feet (4.57 m) apart.

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 noncurrent-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 for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a 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.

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

Identified (conductors or terminals): identified, as used in reference to a conductor or its terminal, means that such conductor or terminal can be recognized as grounded.

Identified (for the use): recognized as suitable for the specific purpose, function, use, environment, application, etc. where described as a requirement in this standard. Suitability of equipment for a specific purpose, environment, or application is determined by a qualified testing laboratory where such identification includes labeling or listing.

Insulated conductor: see "**Conductor**".

Interrupter switch (over 600 volts, nominal): a switch capable of making, carrying, and interrupting specified currents.

Intrinsically safe equipment and associated wiring: equipment and associated wiring in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, under certain prescribed test conditions, of causing ignition of a mixture of flammable or combustible material in air in its most easily ignitable concentration.

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

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

Labeled: equipment or materials to which has been attached a label, symbol or other identifying mark of a qualified testing laboratory which indicates compliance with appropriate standards or performance 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.

Listed: equipment or materials included in a list published by a qualified testing laboratory whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

Location: (a) **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.

(b) **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.

(c) **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 locations exposed to weather and unprotected.

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

Motor control center: an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

Outlet: a point on the wiring system at which current is taken to supply utilization equipment.

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**.")

Portable X-ray: x-ray equipment designed to be hand-carried.

Power fuse (over 600 volts, nominal): see "**Fuse**".

Power outlet: an enclosed assembly which may include receptacles, circuit breakers, fuseholders, fused switches, buses and watt-hour meter mounting means; intended 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 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.

Qualified testing laboratory: a properly equipped and staffed testing laboratory which has capabilities for and which provides the following services:

(a) Experimental testing for safety of specified items of equipment and materials referred to in this standard to determine compliance with appropriate test standards or performance in a specified manner;

(b) Inspecting the run of such items of equipment and materials at factories for product evaluation to assure compliance with the test standards;

(c) Service-value determinations through field inspections to monitor the proper use of labels on products and with authority for recall of the label in the event a hazardous product is installed;

(d) Employing a controlled procedure for identifying the listed and/or labeled equipment or materials tested; and

(e) Rendering creditable reports or findings that are objective and without bias of the tests and test methods employed.

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 windings 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 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 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.

Signaling circuit: any electric circuit that energizes signaling equipment.

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: (a) **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.

(b) **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.

(c) **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.

(d) **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, and interrupter switches.

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, or a Class II combustible liquid having a vapor pressure not exceeding 40 psia (276 kPa) at 38 deg. C (100 deg. F) 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.

Source for definitions: 29 CFR 1926, i.e. OSHA's definitions for terms in the construction industry

Endnotes

1. OSHA Training Institute. (2011). Construction Focus Four: Electrocution Hazards. Instructor Guide. Retrieved from: https://www.osha.gov/dte/outreach/construction/focus_four/

    - OSHA Website
    - BLS Website
    - CDC/NIOSH Website
    - *The Construction Chart Book* (CPWR, 2007)
    - Central New York COSH, 2007, *Construction Safety & Health Electrocution hazards,* Grantee module, Grant Number SH-16586-07-06-F-36 from OSHA
    - CDC/NIOSH in partnership with CPWR-The Center for Construction Research and Training, Hollywood, Health and Society, and the Spanish-language network Telemundo, http://www.cdc.gov/Features/ConstructionElectrocution/
    - Laborers' Health & Safety Fund of North America, *Preventing Electrocution in Construction*, an OSHA Alliance product

