Electrical Safety – Construction (1)

Grounding

Grounding creates a low-resistance path from a tool to the earth to disperse unwanted current.

When a short or lightning occurs, energy flows to the ground, protecting you from electrical shock, injury and death.

Grounding is a secondary method of preventing electrical shock.

Grounded electrical systems are usually connected to a grounding rod that is placed 6-8 feet deep into 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.

Hazard – Improper Grounding

- Tools plugged into improperly grounded circuits may become energized
- Broken wire or plug on extension cord
- Some of the most frequently violated OSHA standards

Control –**The most frequently violated OSHA electrical regulation** is improper grounding of equipment and circuitry. The metal parts of an electrical wiring system that we touch (switch plates, ceiling light fixtures, conduit, etc.) should be grounded and at 0 volts. If the system is not grounded properly, these parts may become energized. Metal parts of motors, appliances, or electronics that are plugged into improperly grounded circuits may be energized. When a circuit is not grounded properly, a hazard exists because unwanted voltage cannot be safely eliminated. If there is no safe path to ground for fault currents, exposed metal parts in damaged appliances can become energized.

Extension cords may not provide a continuous path to ground because of a broken ground wire or plug.

Electrical systems are often grounded to metal water pipes that serve as a continuous path to ground. If plumbing is used as a path to ground for fault current, all pipes must be made of conductive material (a type of metal). Many electrocutions and fires occur because (during renovation or repair) parts of metal plumbing are replaced with plastic pipe, which does not conduct electricity.

Control –Ground Tools & Equipment

- Ground power supply systems, electrical circuits, and electrical equipment
- Frequently inspect electrical systems to insure path to ground is continuous
- Inspect electrical equipment before use
- Don't remove ground prongs from tools or extension cords
- Ground exposed metal parts of equipment

A typical extension cord grounding system has four components:

1. a third wire in the cord, called a ground wire;
2. a three-prong plug with a grounding prong on one end of the cord;
3. a three-wire, grounding-type receptacle at the other end of the cord; and
4. a properly grounded outlet.

Two kinds of grounds are required by the standard:

1. Service or system ground. In this instance, one wire, called the neutral conductor or grounded conductor, is grounded. In an ordinary low-voltage circuit, the white (or gray) wire is grounded at the generator or transformer and again at the service entrance of the building. This type of ground is primarily designed to protect machines, tools, and insulation against damage.
2. For enhanced worker protection, an additional ground, called the equipment ground, must be furnished by providing another path from the tool or machine through which the current can flow to the ground. This additional ground safeguards the electric equipment operator if a malfunction causes the metal frame of the tool to become energized.

Control – Use GFCI (ground-fault circuit interrupter)

- Protects you from shock
- Detects difference in current between the black and white wires
- If ground fault detected, GFCI shuts off electricity in 1/40th of a second
- Use GFCI's on all 120-volt, single-phase, 15- and 20-ampere receptacles, or has an assured equipment grounding conductor program.

Reference 1926.404(b) (1) (i)

GFCI:

- Matches the amount of current going to an electrical device against the amount of current returning from the device.
- Interrupts the electric power within as little as 1/40 of a second when the amount of current going differs from the amount returning by about 5 mA
- Must be tested to ensure it is working correctly.
- NEC requires GFCI's be used in these high-risk situations:
    - Electricity is used near water.
    - The user of electrical equipment is grounded (by touching grounded material).
    - Circuits are providing power to portable tools or outdoor receptacles.
    - Temporary wiring or extension cords are used.

There is one disadvantage to grounding: a break in the grounding system may occur without the user's knowledge. Using a ground-fault circuit interrupter (GFCI) is one way of overcoming grounding deficiencies.

Control - Assured Equipment Grounding Conductor Program

Program must cover:

- All cord sets

- Receptacles not part of a building or structure
- Equipment connected by plug and cord

Program requirements include:

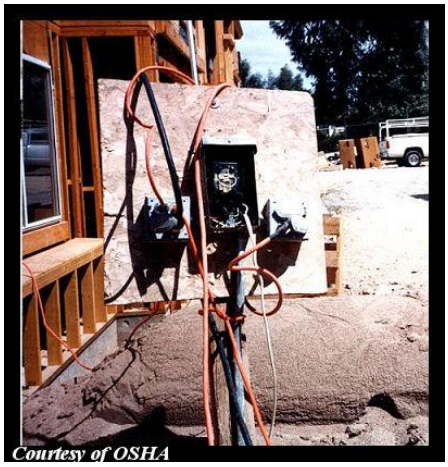
- Specific procedures adopted by the employer
- Competent person to implement the program
- Visual inspection for damage of equipment connected by cord and plug

Reference 1926.404(b) (1) (iii)

Assured Equipment Grounding Conductor Program (AEGCP).

The employer shall establish and implement AEGCP on construction sites covering all listed above which are available for use or used by employees. This program has the following minimum requirements:

- Daily visual inspections,
- Periodic test inspections (3 months at most for temporary cords and cords exposed to damage, 6 months for fixed cords not exposed)
- Written description,
- A competent person to implement the program, and



- Record of the periodic tests.

When portions of the building(s) or structures(s) which have been completed and no longer expose employees to weather or damp and wet locations, or to other grounding hazards, GFCIs or an assured equipment grounding program may not be required when approved extension cords are plugged into the permanent wiring at construction sites.

Hazard – Overloaded Circuits

Hazards may result from:

- Too many devices plugged into a circuit, causing heated wires and possibly a fire
- Damaged tools overheating
- Lack of over current protection
- Wire insulation melting, which may cause arcing and a fire in the area where the overload exists, even inside a wall

If the circuit breakers or fuses are too big (high current rating) for the wires they are supposed to protect, an overload in the circuit will not be detected and the current will not be shut off. A circuit with improper over current protection devices – or one with no over current protection devices at all – is a hazard.

Control - Electrical Protective Devices

- Automatically opens circuit if excess current from overload or ground-fault is

detected – shutting off electricity

- Includes GFCI's, fuses, and circuit breakers
- Fuses and circuit breakers are over current devices. When too much current:
    - Fuses melt
    - Circuit breakers trip open

To prevent too much current in a circuit, a circuit breaker or fuse is placed in the circuit. If there is too much current in the circuit, the breaker "trips" and opens like a switch. If an overloaded circuit is equipped with a fuse, an internal part of the fuse melts, opening the circuit. Both breakers and fuses do the same thing: open the circuit to shut off the electrical current

The basic idea of an over current device is to make a weak link in the circuit. In the case of a fuse, the fuse is destroyed before another part of the system is destroyed. In the case of a circuit breaker, a set of contacts opens the circuit. Unlike a fuse, a circuit breaker can be re-used by re-closing the contacts. Fuses and circuit breakers are designed to protect equipment and facilities, and in so doing, they also provide considerable protection against

shock in most situations. However, the only electrical protective device whose sole purpose is to protect people is the ground-fault circuit-interrupter.

Power Tool Requirements

- Have a three-wire cord with ground plugged into a grounded receptacle, or
- Be double insulated, or
- Be powered by a low-voltage isolation transformer

Common Examples of Misused Equipment = OSHA Violations

- 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, e.g., removing ground prongs, face plates, insulation, etc.

- Using cords or tools with worn insulation or exposed wires.

Tool Safety Tips

- Use gloves and appropriate footwear
- Store in dry place when not using
- Don’t use in wet/damp conditions
- Keep working areas well lit
- Ensure not a tripping hazard
- Don’t carry a tool by the cord
- Don’t yank the cord to disconnect it
- Keep cords away from heat, oil, & sharp edges
- Disconnect when not in use and when changing accessories such as blades & bits
- Remove damaged tools from use

Avoid accidental starting. Don’t hold fingers on switch button while carrying a plugged-in tool.

Tag damaged tools: "Do Not Use."

Hazards of portable electric tools:

- Currents as small as 10 mA can paralyze, or “freeze” muscles: person cannot release tool.

- Tools are held tightly, resulting in longer shock exposure.
- Power drills use 30 times as much current as what will kill.

Courtesy of OSHA

Preventing Electrical Hazards – Tools

- Inspect tools before use
- Use the right tool correctly
- Protect your tools
- Use double insulated tools
- Use tools and equipment according to the instructions included in their listing, labeling or certification.
- Visually inspect all electrical equipment before use. Remove from service any equipment with frayed cords, missing ground prongs, cracked tool casings, etc. Apply a warning tag to any defective tool and do not use it until the problem has been corrected.

Temporary Lights

Protect from contact and damage, and don't suspend by cords unless designed to do so.


Courtesy of OSHA

Clues that Electrical Hazards Exist

- Tripped circuit breakers or blown fuses
- Warm tools, wires, cords, connections, or junction boxes
- GFCI that shuts off a circuit
- Worn or frayed insulation around wire or connection

There are "clues" that electrical hazards exist. For example, if a GFCI keeps tripping while you are using a power tool, there is a problem. Don't keep resetting the GFCI and continue to work. You must evaluate the "clue" and decide what action should be taken to control the hazard.

There are a number of other conditions that indicate a hazard.

- Tripped circuit breakers and blown fuses show that too much current is flowing in a circuit. This could be due to several factors, such as malfunctioning equipment or a short between conductors. You need to determine the cause in order to control the hazard.
- An electrical tool, appliance, wire, or connection that feels warm may indicate too much current in the circuit or equipment. You need to evaluate the situation and determine your risk.

- An extension cord that feels warm may indicate too much current for the wire size of the cord. You must decide when action needs to be taken.
- A cable, fuse box, or junction box that feels warm may indicate too much current in the circuits.
- A burning odor may indicate overheated insulation.
- Worn, frayed, or damaged insulation around any wire or other conductor is an electrical hazard because the conductors could be exposed. Contact with an exposed wire could cause a shock. Damaged insulation could cause a short, leading to arcing or a fire. Inspect all insulation for scrapes and breaks. You need to evaluate the seriousness of any damage you find and decide how to deal with the hazard.§ A GFCI that trips indicates there is current leakage from the circuit First, you must decide the probable cause of the leakage by recognizing any contributing hazards. Then, you must decide what action needs to be taken.

Lockout and Tagging of Circuits

- Apply locks to power source after de-energizing
- Tag deactivated controls
- Tag de-energized equipment and circuits at all points where they can be energized
- Tags must identify equipment or circuits being worked on

Reference 1926.417:

(a) Controls. Controls that are to be deactivated during the course of work on energized or de-energized equipment or circuits shall be tagged.

(b) Equipment and circuits. Equipment or circuits that are deenergized shall be rendered inoperative and shall have tags attached at all points where such equipment or circuits can be energized.

(c) Tags. Tags shall be placed to identify plainly the equipment or circuits being worked on.

(d) Lockout and tagging. While any employee is exposed to contact with parts of fixed electric equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out or tagged or both.

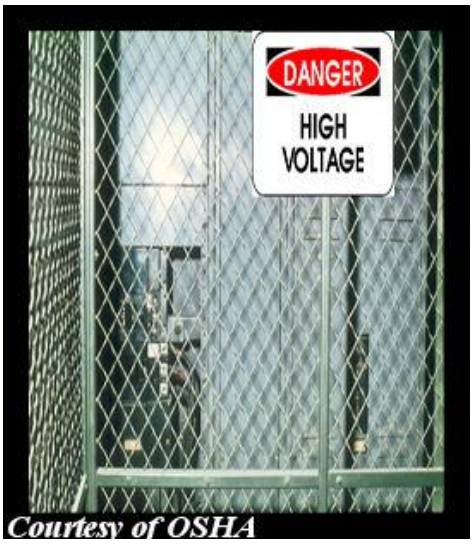
Case study

An electrician was removing a metal fish tape from a hole at the base of a metal light pole.

(A fish tape is used to pull wire through a conduit run.) The fish tape became energized, electrocuting him. As a result of its inspection, OSHA issued a citation for three serious violations of the agency's construction standards.

If the following OSHA requirements had been followed, this death could have been prevented.

- De-energize all circuits before beginning work.
- Always lock out and tag out de-energized equipment.
- Companies must train workers to recognize and avoid unsafe conditions



Safety-Related Work Practices

To protect workers from electrical shock:

- Use barriers and guards to prevent passage through areas of exposed energized equipment
- Pre-plan work, post hazard warnings and use protective measures
- Keep working spaces and walkways clear of cords

1926.416, 1926.417

Employees must not work near any part of an electric power circuit that the employee could contact in 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.

- In work areas where the exact location of underground electric power lines is unknown, employees using jack-hammers, bars, or other hand tools which may contact a line shall be provided with insulated protective gloves.
- Before work is begun, inquire or observe by instruments whether any part of an energized electric power circuit is so located that the performance of the work may bring any person, tool, or machine into physical or electrical contact with the electric power circuit. Post and maintain proper warning signs where such a circuit exists. The employer shall advise employees of the location of such lines, the hazards involved, and the protective measures to be taken.

Safety-Related Work Practices

- Use special insulated tools when working on fuses with energized terminals
- Don’t use worn or frayed cords and cables
- Don’t fasten extension cords with staples, hang from nails, or suspend by wire.

1926.416, 1926.417

Only qualified persons may work on electric circuit parts or equipment that has not been deenergized. Such persons shall be capable of working safely on energized circuits and

shall be familiar with the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools.

Deenergize live parts that an employee may be exposed to before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Live parts that operate at less than 50 volts to ground need not be deenergized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

If the exposed live parts are not deenergized other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards. Employees must be protected against contact with energized circuit parts with any part of their body or indirectly through some other conductive object.

Lock or tag out (or both) the circuits energizing the parts while any employee is exposed to contact with parts of fixed electric equipment or circuits which have been deenergized.

If working near overhead lines, the lines shall be deenergized and grounded, or other protective measures shall be provided before work is started.

Portable cord and plug connected equipment and extension cords shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket).

Preventing Electrical Hazards - Planning

Courtesy of OSHA

- Plan your work with others
- Plan to avoid falls
- Plan to lock-out and tag-out equipment
- Remove jewelry
- Avoid wet conditions and overhead power lines

Make your environment safer by doing the following:

- Lock and tag out circuits and machines.
- Prevent overloaded wiring by using the right size and type of wire.
- Prevent exposure to live electrical parts by isolating them.
- Prevent exposure to live wires and parts by using insulation.
- Prevent shocking currents from electrical systems and tools by grounding them.
- Prevent shocking currents by using GFCI's.
- Prevent too much current in circuits by using over current protection devices.


Courtesty of OSHA

Avoid Wet Conditions

- If you touch a live wire or other electrical component while standing in even a small puddle of water you'll get a shock.

- Damaged insulation, equipment, or tools can expose you to live electrical parts.
- Improperly grounded metal switch plates & ceiling lights are especially hazardous in wet conditions.
- Wet clothing, high humidity, and perspiration increase your chances of being electrocuted.

A damaged tool may not be grounded properly, so the housing of the tool may be energized, causing you to receive a shock.

Improperly grounded metal switch plates and ceiling lights are especially hazardous in wet conditions. If you touch a live electrical component with an un-insulated hand tool, you are more likely to receive a shock when standing in water. But remember: you don't have to be standing in water to be electrocuted. Wet clothing, high humidity, and perspiration also increase your chances of being electrocuted.

Use extra caution when working with electricity when water is present in the environment or on the skin. Pure water is a poor conductor, but small amounts of impurities, like salt and acid (both are in perspiration), make it a ready conductor.

Preventing Electrical Hazards – PPE

- Proper foot protection (not tennis shoes)
- Rubber insulating gloves, hoods, sleeves,

matting, and blankets Hard hat (insulated - nonconductive)

Personal protective equipment (PPE) should always be the last line of defense against a hazard. If the hazard is unavoidable, and cannot be addressed in any other safe manner, then employees must be fitted with proper PPE.

Safety shoes should be nonconductive and protect your feet from completing an electrical circuit to ground. They can also protect against open circuits of up to 600 volts in dry conditions. These shoes should be used with other insulating equipment and in connection with active precautions to reduce or eliminate the potential for providing a path for hazardous electrical energy.

When it is necessary to handle or come close to wires with a potential live electrical charge, it is essential to use proper insulating PPE to protect employees from contact with the hazardous electrical energy.

Specific types of hard hats are needed when performing electrical work.

A "Class B" Electrical/Utility type hard hat protects against falling objects and high-voltage shock and burns.

Preventing Electrical Hazards – Proper Wiring and Connectors

- Use and test GFCI's
- Check switches and insulation

- Use three prong plugs
- Use extension cords only when necessary & assure in proper condition and right type for job
- Use correct connectorsIf the polarity is reversed on a GFCI, the lights will test well, but the press to test button will not trip the circuit.

Training

- Deenergize electric equipment before inspecting or repairing
- Using cords, cables, and electric tools that are in good repair
- Lockout / Tagout recognition and procedures
- Use appropriate protective equipment

1926.21(b) (2)

De-energizing Electrical Equipment.

Accidental or unexpected starting of electrical equipment can cause injury or death. Before ANY inspections or repairs are made, the current must be turned off at the switch box and the switch padlocked in the OFF position. At the same time, the switch or controls of the machine or other equipment being locked out of service must be securely tagged to show which equipment or circuits are being worked on.

Employees shall be trained in and familiar with the safety-related work practices that pertain to their respective job assignments.

Summary – Hazards & Protections

Hazards

- Inadequate wiring
- Exposed electrical parts
- Wires with bad insulation
- Ungrounded electrical systems and tools
- Overloaded circuits
- Damaged power tools and equipment
- Using the wrong PPE and tools
- Overhead powerlines
- All hazards are made worse in wet conditions

Protective Measures

- Proper grounding
- Use GFCI's
- Use fuses and circuit breakers
- Guard live parts
- Lockout/Tag out
- Proper use of flexible cords
- Close electric panels
- Training

Electrical equipment must be:

- Listed and labeled
- Free from hazards
- Used in the proper manner

If you use electrical tools you must be:

- Protected from electrical shock
- Provided necessary safety equipment