Controlling Electrical Hazards:

OSHA standards cover many electrical hazards in many different industries. OSHA’s general industry electrical safety standards are published in Title 29 Code of Federal Regulations (CFR), Part 1910.302 through 1910.308- Design Safety Standards for Electrical Systems, and 1910.331 through 1910.335- Electrical Safety- Related Work Practices Standards.

OSHA’s electrical standards are based on the National Fire Protection Association Standards (NFPA 70), National Electric Code and NFPA 70 E, Electrical Safety Requirements for Employee Workplaces.

OSHA also has electrical safety standards for the construction industry, in 29 CFR 1926, Subpart K. OSHA’s standards for marine terminals, in 29 CFR 1917, and for longshoring, in 29 CFR 1918, reference the general industry electrical standards in Subpart S of Part 1910. The shipyard standards, in 29 CFR 1915, cover limited electrical safety work practices in 29 CFR 1915.181.

Electricity: The Basics- What affects the flow of electricity?

Electricity flows more easily through some materials than others. Substances such as metals offer little resistance to the flow of electric current and are called “conductors”. A common but perhaps overlooked conductor is the surface or subsurface of the earth. Glass, plastic, porcelain, clay, pottery, dry wood and similar substances generally slow or stop the flow of electricity. They are called “insulators”. Even air, normally an insulator, can become a conductor, as occurs during a lightning strike or an arc.

How does water affect the flow of electricity?

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

What Causes Shocks?

Electricity travels in closed circuits, normally through a conductor. But sometimes a person’s body which is an efficient conductor of electricity mistakenly becomes part of the electric circuit. This can cause a shock. Shocks occur when a person’s body completes the current path with both wires of an electric circuit, one wire of an energized circuit and the ground, a metal part that accidently becomes energized due to, for example, a break in the insulation; or another “conductor” that is carrying a current. When a person receives a shock, electricity flows between the parts of the body or through the body to a ground or the earth.

What effect do shocks have on the body?

An electric shock can result in anything from a slight tingling sensation to immediate cardiac arrest. The severity depends on the amount of current flowing through the body, the current’s path through the body, the length of time the body remains in the circuit and the current’s frequency.

What kind of burns can a shock cause?

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

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

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

Thermal contact burns are caused when the skin touches hot surfaces of overheated electrical conductors, conduits or other energized equipment. Thermal burns also can be caused when clothing catches on fire, as when an electric arc is produced.

In addition to shock and burn hazards, electricity poses other dangers. For example, arcs that result from

Short circuits can cause injury or start a fire. Extremely high-energy arcs can damage equipment, causing fragmented metal to fly in all directions. Even low-energy arcs can cause violent explosions in atmospheres that contain flammable gases, vapors or combustible dusts.

Why do people sometimes “freeze” when they are shocked?

When a person receives an electrical shock, sometimes the electrical stimulation causes the muscles to contract. This “freezing” effect makes the person unable to pull free of the circuit. It is extremely dangerous because it increases the length of exposure to electricity and because the current causes blisters, which reduce the body’s resistance and increases the current. The longer the exposure, the greater the risk of serious injury. Longer exposure at even relatively low voltages can be just as dangerous as short exposures at higher voltages. Low voltage does not imply low hazard.

In addition to muscle contractions that cause “freezing”, electrical shocks also can cause involuntary muscle reactions. These reactions can result in a wide range of other injuries from collisions or falls, including bruises, bone fractures and even death.

What should you do if someone “freezes” to a live electrical contact?

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

How can you tell if a shock is serious?

A severe shock can cause considerably more damage than meets the eye. A victim may suffer internal hemorrhages and destruction of tissues, nerves and muscles that aren’t readily visible. Renal damage also can occur. If you or a coworker receives a shock, seek emergency medical help immediately.

What is the danger of static electricity?

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

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

Protection against Electrical Hazards

What is the best way to protect you against electrical hazards?

Most electrical hazards result from one of the following factors; unsafe equipment or installation, unsafe environment or unsafe work practices. Some ways to prevent these accidents are through the use of insulation, guarding, grounding, electrical protective devices and safe work practices.

What Protection does insulation provide?

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

How do you identify different types of insulation?

Insulation on conductors is often color coded. Insulated equipment grounding conductors usually are either solid green or green with yellow stripes. Insulation covering grounded conductors is generally white or gray. Ungrounded conductors or “hot wires” often are black or red, although they may be any color other than green, white or gray.

Before connecting electrical equipment to a power source, it is a good idea to check the insulation for any exposed wires for possible defects. Insulation covering flexible cord such as extension cords is particularly vulnerable to damage.

The insulation that covers conductors in non-construction applications is regulated by Subpart S of 29 CFR 1910.302 through 1910.308, Wiring Design and Protection. Subpart S generally requires insulation on circuit conductors. It also specifics that the insulation used should be suitable for voltage and conditions. Conductors used in construction applications are regulated by Subpart K of 29 CFR 1926.402 through 1926.408.

What is guarding and what protection does it offer?

Guarding involves locating or enclosing electrical equipment to make sure people do not accidently come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where it is accessible only to authorized people qualified to work with it. Recommended locations are a room, vault, or similar enclosure; a balcony, gallery or elevated platform; or site elevated 8 feet or more above the floor. Sturdy, permanent screens also can serve as effective guards.

Conspicuous signs must be posted at the entrance to electrical rooms and similarly guarded locations to alert people to the electrical hazard and to forbid entry to unauthorized people. Signs may contain the word “Danger”, “Warning” or “Caution” and beneath that, appropriate concise words that alerts people to the hazard or gives an instruction, such as “Danger/High Voltage/Keep Out”.

What is grounding and what protection does it offer?

“Grounding” a tool or electrical system means intentionally creating a low-resistance path that connects to the earth. This prevents the buildup of voltages that could cause an electrical accident.

Grounding is normally a secondary protective measure to protect against electric shock. It does not guarantee that you won’t get a shock or be injured or killed by an electrical current. It will, however, substantially reduce the risk, especially when used in combination with other safety measures discussed in this booklet.

29CFR, Part 1910.304, Subpart S, Wiring Design and Protection, requires at times a service or system ground and an equipment ground in non-construction applications.

A service or system ground is designed primarily to protect machines, tools, and insulation against damage. One wire, called the “neutral” or “grounded” conductor is grounded. In an ordinary low voltage circuit, the white or gray wire is grounded at the generator or transformer at the building’s service entrance.

An equipment ground helps protect the equipment operator. It furnishes a second path for the current to pass through from the tool or the machine to the ground. This additional ground safeguards the operator if a malfunction causes the tool’s metal frame to become energized. The resulting flow of current may activate the circuit protection devices.

What are the circuit protection devices and how do they work?

Circuit protection devices limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Well-known examples of these devices are fuses, circuit breakers, ground-fault circuit interrupters and arc-fault interrupters.

Fuses and circuit breakers open or break the circuit automatically when too much current flows though them. When that happens, fuses melt and circuit breakers trip the circuit open. Fuses and circuit breakers are designed to protect conductors and equipment. They prevent wires and other components from overheating and open the circuit when there is a risk of a ground fault.

Ground-fault circuit interrupters, or GFCIs, are used in wet locations, construction sites and other high risk areas. These devices interrupt the flow of electricity within as little as 1/40 of a second to prevent electrocution. GFCIs compare the amount of current going into electric equipment with the amount of current returning it from it along the circuit conductors. If the difference exceeds 5 milliamperes, the device automatically shuts off the electric power.

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

What work practices help protect you against electrical hazards?

Electrical accidents are preventable through safe work practices. Examples of safe work practices include: deenergize electric equipment before inspection or repair, keeping tools properly maintained, exercising caution when working near energized lines, using appropriate protective equipment.

Electrical safety-related work practice requirements for general industry are detailed in Subpart S of 29 CFR Part 1910, in Sections 1910.331- 1910.335. For construction applications, electrical safety-related work practice requirements are detailed in Subpart K of 29 CFR Part 1926.416 to 1926.417.

How can you protect yourself against metal parts that become energized?

A break in an electric tool’s or machine’s insulation can cause its metal parts to become “hot” or energized, meaning that they conduct electricity. Touching these energized parts can result in an electric shock, burn or electrocution. The best way to protect yourself when using electrical tools or machines is to establish a low resistance path from the device’s metallic case to the ground. This requires an equipment grounding conductor, a low resistance wire that directs unwanted current directly to the ground. A properly installed grounding conductor has a low resistance to ground and greatly reduces the amount of current that passes through your body. Cord and plug equipment with a three-prong plug is a common example of equipment incorporating this ground conductor.

Another form of protection is to use listed or labeled portable tools and appliances protected by an approved system of double insulation or its equivalent. Where such a system is employed, it must be marked distinctively to indicate that the tool or appliance uses an approved double insulated system.

How can you prevent an accidental or unexpected equipment startup?

Proper lockout/tagout procedures protect you from the dangers of accidental or unexpected startup of electrical equipment and are required for general industry by OSHA Standard 1910.333, Selection and Use of Work Practices, Requirements for construction applications are in 29 CFR 1926.417, Lockout and tagging of Circuits. These procedures ensure that electrical equipment is deenergized before it is repaired or inspected and protects you against electrocution or shock.

The first step before beginning any inspection or repair job is to turn the current off at the switch box and padlock the switch in the OFF position. This applies even to so called low voltage circuits. Securely tagging the switch or controls of the machine or equipment being locked out of service clarifies to everyone in the area which equipment or circuits are being inspected or repaired.

Only qualified electricians who have been trained in safe lockout procedures should maintain electrical equipment. No two of the locks used should match, and each key should fit just one lock. In addition, one individual lock and key should be issued to each maintenance worker authorized to lock out and tag the equipment. All employees who repair a given piece of equipment should lock out its switches with an individual lock. Only authorized workers should be permitted to remove it.

How can you protect yourself from overhead power lines?

Before working under or near overhead power lines, ensure that you maintain safe distance to the lines and, for very high voltage lines, ground any equipment that can become energized. If working on power lines, ensure that the lines have been deenergized and grounded by the owner or operator of the lines. Other protective measures like guarding or insulating the lines help prevent accidental contact.

Employees unqualified to work with electricity, as well as mechanical equipment, should remain at least 10 feet away from overhead power lines. If the voltage is more than 50,000 volts, the clearance increases by 4 inches for each 10,000 volts.

When mechanical equipment is operated near overhead lines, employees standing on the ground should avoid contact with equipment unless it is located outside the danger zone. When factoring safe standoff distance, be sure to consider the equipment’s maximum reach.

What protection does personal equipment offer?

Employees who directly work with electricity should use personal protective equipment for the jobs they perform. This equipment may include rubber insulating gloves, hoods, sleeves, matting, blankets, line hose and industrial protective helmets designed to reduce electric shock hazard. All help reduce the risk of electrical accidents.

What role do tools play?

Appropriate and properly maintained tools help protect workers against electric hazards. It’s important to maintain tools regularly because it prevents them from deteriorating and becoming dangerous. Check each tool before using it. If you find a defect, immediately remove it from service and tag it so no one will use it until it has been repaired or replaced.

Ehen using a tool to handle energized conductors, check to make sure it is designed and constructed to with stand the voltages and stresses to which it has been exposed.

What special training do employees need?

All employees should be trained to be thoroughly familiar with safety procedures for their particular jobs. Moreover, good judgment and common sense are integral to preventing electrical accidents. When working on electrical equipment, for example, some basic procedures to follow include: deenergize the equipment, use lock out and tag procedures to ensure that the equipment remains deenergized, use insulating protective equipment and maintain a safe distance from energized parts.