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Electrical Safety Summary

Electrical Safety

Quick Tips #266

Electricity is a powerful source of energy that powers lights, tools, machinery and many other devices necessary for our day-to-day work. Electricity can also be a hazard causing injury or death. Experts in the electrical industry look to the National Electric Code (NEC) for the electrical safety standards on how to correctly assemble and maintain electrical circuits and the National Electric Safety Code (NESC) for the basic provisions for safeguarding persons from hazards when installing, operating or maintaining electric currents.

OSHA recognized the importance of the NEC and included the 1971 edition into Subpart K of the 29 CFR 1926 for the construction industry. They have since made updates, revised and clarified the standard to make it more flexible in order to eliminate the need for the constant revision to keep pace with the NEC, which is updated every 3 years. For the general industry, OSHA has dedicated 29 CFR 1910 Subpart S to electrical safety. On February 14, 2007, OSHA published a final rule revising the electrical installation standards found in Subpart S that are intended to reduce the risk of injury and death caused by unsafe electrical installations. This revised standard became effective on August 13, 2007.

Some of the requirements of sections 29 CFR 1910.303 through 1910.308 do not apply to all electrical installations. It can be difficult to determine which requirements apply to the installation based on the time period in which the equipment was built or last modified. To remedy this problem OSHA has developed an interactive eTool designed to assist employers determining what regulation applies to them based on the date of installation or modification of the equipment.

Electricity and Its Effects on the Body

In order for electricity to work, a complete circuit made of a conductor, a load or electricity-consuming device and a ground is needed. Electricity will flow through the conductor to the load and finally to the ground to complete the circuit. Electricity will follow the path of least resistance to ground—similar to water in a pipeline that flows out of a valve when it is opened. Electricity becomes dangerous when you become part of the circuit, because the closest path to ground may be through you, causing an electrical shock.

When you are shocked by electricity, your muscles contract. If the lungs are involved in the path of the circuit, voluntary respiration can be halted. If the heart is involved, fibrillation can occur resulting in heart failure. As little as 50 milliamperes can cause death. It is important to realize that an electrical shock may not be strong enough to cause a fatality but it could cause you to fall or jolt to dangerous surroundings. For details on the effects electricity has on the body, see table 1.

Qualified Personnel vs. Unqualified Personnel

The 29 CFR 1910 Subpart S identifies two types of people that may come in to contact with electrical equipment on a jobsite: qualified and unqualified. A qualified person is one who has been trained to avoid electrical hazards when working on or near exposed energized parts and is:

- Familiar with the safety-related work practices required in 29 CFR 1910.331-1910.335
- Able to distinguish exposed live parts of electrical equipment
- Knowledgeable of the skills and techniques used to determine the nominal voltages of exposed parts

An unqualified person is someone who has little or no training regarding electrical hazards. Even though unqualified persons may not be exposed to energized parts, training should still be provided so they can be familiar with any necessary electrical safety practice.

Electrical Safety Practices at Work

Safe work practices are used to prevent electrical shock or similar injuries by keeping workers away from energized equipment or circuits and by training qualified workers on the correct procedures when working on energized equipment or circuits. Prior to using or performing maintenance on electrical equipment, the employee should first determine if it is safe by checking the following:

- Make sure the electrical equipment is not located in a hazardous environment, such as a damp/wet location or where it is exposed to high temperatures and flammable liquids and gases
- Make sure current and safety devices, such as fuses, breakers and ground fault circuit interrupters (GFCI), have not been tampered with and are working correctly
- Make sure the power cord and plug do not have any defects, such as cuts in the insulation exposing bare wiring
- Know if the equipment has an emergency shutoff switch and where it is located prior to use

- Make sure there is sufficient space around the electrical equipment or circuit in order to maintain or operate
- Make sure all personal metal jewelry is removed prior to using or working on electrical equipment or circuits
- De-energize electrical equipment before testing or repairing in accordance with the Lockout Tagout standard 29 CFR 1910.147.

If de-energizing the electrical equipment or circuit will increase the potential for an electrical hazard or is necessary for testing and troubleshooting, the appropriate tools and personal protective equipment (PPE) must be used and worn for the specific parts of the body to be protected.

Insulated Tools

Insulated tools must be used when working on or near exposed energized live conductors. Only insulated tools that comply with the International Electrotechnical Commission standard 900 (IEC 900) and marked with the international 1000V rating symbol should be used. Not all tools with a plastic coating or plastic handles provide protection from electrical shock. It is important to inspect your tools before performing electrical work—not only to verify if the tools are rated for the job, but also to check for damage, wear and if they no longer provide adequate protection from electrical shock. Damaged or worn tools should be removed from service immediately.

Electrical Protective Equipment

Electrical protective equipment, also known as insulating equipment, includes items such as insulated blankets, matting, covers, line hose, gloves, sleeves, face shields and arc flash clothing. Blankets, gloves and sleeves are clearly marked with class and type, while clothing is labeled with an arc thermal performance value rating (ATPV) measured in calories per square centimeter (i.e. 65 cal/cm). The class refers to the maximum-use voltage. Insulating must not exceed maximum-use voltages (see table 2). The type refers to ozone resistance. Type I is not ozone resistant. Type II is ozone resistant. The ATPV rating cal/cm identifies the amount of energy that can be delivered to a point at a particular distance from an arc flash. The higher the number, the more protection the clothing offers.

Insulated equipment should be inspected prior to each day's use and immediately following an incident that may have caused damage. Damage consists of holes, tears, cuts, punctures, ozone cutting, embedded foreign objects, swelling, softening, hardening or any other defect. Once an insulated piece of equipment is removed from service, it may not be reused until it has been retested and certified. All electrically insulated equipment must also be retested and certified periodically. See table 3 for testing intervals.

Employee Training

Electrical safety is the responsibility of everyone on the jobsite. It is important to establish a hazard assessment program that includes employee training on electrical safety. Training employees on the basics of electrical safety should include its effects on the body, first aid procedures when someone is shocked, how to fight an electrical fire and how to identify hazards. Some do's and dont's that can assist in electrical safety training include:

DO'S

- Read and follow electrical equipment instruction manuals prior to using
- Use safety signs, barricades and tags to identify and protect electrical equipment
- Only use extension cords as a last resort
- Use waterproof cords in an outdoor application
- Contact a certified electrician when electrical repair is needed

DONT'S

- Overload outlets by using splitters
- Touch electrical equipment, including power cords with wet or damp hands
- Allow dirt, grease or dust to accumulate on electrical equipment
- Use temporary wiring in place of permanent wiring
- Use cords or equipment that are not properly grounded

Commonly Asked Questions

Q. **Does insulated equipment need to be approved or certified?**

A. Insulated equipment must be certified by the manufacturer to be suitable for giving the proper usage and for the specified conditions to which they are exposed. The certificate identifies the equipment and the date tested.

Q. **Is there an expiration date for insulated equipment after which it must be destroyed?**

A. No. As long as the insulated equipment is in a safe, reliable condition and retested periodically as required by 29 CFR 1910.137, it may continued to be used. (See table 3.)

Q. **Where can I find out what level of personal protection I need to wear for my application?**

A. The NFPA 70E includes a table that identifies what level of personal protective equipment should be worn when working on energized equipment or circuits.

Sources for More Information

OSHA Subpart S – Electrical Standard eTool
2011 NEC
29 CFR 1910 Subpart S
29 CFR 1910.137
29 CFR 1910.147
Quick Tips #263 NFPA 70E: Electrical Safety Summary
Winburn D.C. Practical Electrical Safety. Marcel Dekker, INC. 1988

Table 1: Effects of Electricity on the Body

	Milliamperes (Thousandths of an ampere)	
Body Effect	DC Voltage	AC Voltage 60 hz
No sensation on hand	0.6 - 1	0.3 - 0.4
Slight tingling	3.5 - 5.2	0.7 - 1.1
Non-painful shock, muscular control not lost	6 - 9	1.2 - 1.8
Painful shock, muscular control not lost	41 - 62	6 - 9
Severe shock, muscular control lost, difficult breathing	60 - 90	15 - 23
Fibrillation from shock, 3-second duration	500	100

Table 2: Class and Use Voltages

Class	*Maximum Use Voltage*	*Proof Test (AC)*	*Retest Voltage (AC)*	*Proof Test (DC)*	*Retest Voltage (DC)*

0	1,000	5,000	5,000	20,000	20,000
1	7,500	10,000	10,000	40,000	40,000
2	17,000	20,000	20,000	50,000	50,000
3	26,500	30,000	30,000	60,000	60,000
4	36,000	40,000	40,000	70,000	70,000

Table 3: Protective Equipment Test Schedules

Type of Equipment	*When to Test*
Line hose	Upon indication that insulating value is suspect
Covers	Upon indication that insulating value is suspect
Blankets	Before first issue and every 12 months thereafter*
Gloves	Before first issue and every 6 months thereafter*
Sleeves	Before first issue and every 12 months thereafter*

**If insulating equipment has been tested but not issued for service, it may not be placed into service unless it has been tested within the previous 12 months.*