



Technical Diagnostic Services

Examines Electrical Safety

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There is no question that electrical safety is a key concern for electricians and engineers, their employers, unions and the government.

Every day, an average of 9,000 workers in the U.S. suffer disabling injuries on the job. Insurance industry estimates put the direct cost of workplace injuries in 1999 at more than \$40 billion.* With costs that high, no wonder so many government agencies and private groups hold pieces of the safety puzzle.

* Source: NIOSH

To maximize safety for yourself and your team, you need a solid understanding of the rules and standards that govern safe electrical work. This article will help you cut through the alphabet soup of safety organization names to see how each plays a role in safety.

We'll check them out in two groups. First, we'll look at the government agencies that oversee workplace safety, such as the U.S. Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).

Then we'll examine the independent safety and standards organizations, including the National Fire Protection Association (NFPA), the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE) and the International Electro- Technical Commission (IEC). Though they're not part of government, they too help set the rules of the safety game.

The government agencies

First, where did OSHA and NIOSH come from, and what do they do?

Both agencies were created by the federal Occupational Safety and Health Act of 1970. OSHA is in the U.S. Department of Labor and is responsible for developing and enforcing workplace safety and health regulations. In addition, many states have their own occupational safety agencies that work with OSHA and govern workplace safety on the state level.

NIOSH is an agency of the U.S. Department of Health and Human Services, established to help assure safe and healthful working conditions by providing research, information, education, and training in the field of occupational safety and health.

In other words, OSHA sets and enforces the rules, while NIOSH provides helpful information on workplace safety. Here are some examples:

Several OSHA regulations have an impact on electrical workplace safety. For instance:

29 CFR (Code of Federal Regulations) 1910 Subpart I sets standards for Personal Protective Equipment (PPE), including eye and face protection, footwear and protection for electrical workers, such as insulating blankets, gloves and sleeves.

The key electrical safety rules are part of 29 CFR 1910 Subpart S, including design safety standards for electrical systems, safe work practices, maintenance requirements and safety requirements for special equipment. This regulation also covers training requirements, sets guidelines for work on energized parts, outlines lockout/tagout procedures and provides rules for use of PPE in electrical work. The OSHA website provides other electrical safety resources.

While OSHA sets the broad safety agenda, it leaves some details to others. For example, the OSHA electrical safety rules in 1910 Subpart S specifically refer the reader to NFPA and ANSI codes and standards for help in complying with OSHA. These include NFPA 70E (Standard for Electrical Safety in the Workplace), ANSI/NFPA 70 (National Electrical Code) and others.

Here's an example of how the standards work together. OSHA's safety-related work practice standards in Subpart S do not currently address flame-resistant (FR) clothing. However, OSHA standard 29 CFR 1910.335 (a)(2)(ii) requires use of protective shields, protective barriers, or insulating materials to protect employees from shock, burns or other electrically related injuries while working near exposed energized parts or where dangerous electric heating or arcing might occur. Chapter 1 of NFPA 70E-2004 contains specific requirements and methodology for hazard assessment and selection of protective clothing and other

personal protective equipment (PPE). Employers may follow NFPA 70E flash-hazard requirements as a way of meeting the OSHA standard.

The key distinction is this:

OSHA 1910 Subpart S and other OSHA safety and health standards are law. Failure to follow these standards could result in a citation, a work shutdown, fines or other sanctions. The NFPA, ANSI and other standards OSHA refers to, on the other hand, are intended as guidelines to safety.

"We're pointing employers and employees to these documents as sources for additional information," said David Wallis, director of the OSHA office of engineering safety. "For safe work practices there are some general type requirements in OSHA 1910 related to protection from electric shock and electric arc hazard. Employers can look toward NFPA 70E for more specific information about the kind of equipment they need to protect their employees." "There is another caveat I might explain," Wallis continued. "Sometimes OSHA will have a specific requirement not contained in NFPA 70E, or where the 70E provision might not be quite as stringent. In that case, OSHA would expect employers to comply with the OSHA standard. Compliance with NFPA 70E would not automatically be considered adequate."

While OSHA sets the rules, and sometimes levels penalties, NIOSH provides useful safety information. A good example is a new 88-page electrical safety handbook, *Electrical Safety - Safety and Health for Electrical Trades Student Manual*, available for downloading in portable document format. The NIOSH website also provides a number of electrical safety alerts, reports and links to other electrical safety resources.

NFPA establishes standards through consensus. Outside government, a key player in establishing electrical safety practices is the nonprofit National Fire Protection Association. The NFPA sets and updates more than 300 safety codes and standards, covering everything from building construction to connectors for fire hose. NFPA standards are set through consensus, developed by more than 200 committees of volunteers from industry, unions and other interest groups.

For electrical workplace safety, the key NFPA standard is NFPA 70E, *Standard for Electrical Safety in the Workplace*. The 2004 edition was issued by the NFPA Standards Council and approved as an American National Standard in February 2004. NFPA 70E is written to correlate with the National Electrical Code (NEC), which many jurisdictions adopt as part of local building codes and regulations. But NFPA 70E focuses on such issues as safety-related work practices, maintenance of safety equipment, safety requirements for special equipment and safety-related installation requirements. It is intended for use by employers, employees, and OSHA.

NFPA 70E uses six categories of hazard and risk for electrical work, from minus one up to four. As the work environment and the type of job become more hazardous, the need for protection increases. The standard also makes it clear that test

equipment is rated and designed for the circuits and environments where it will be used, and inspected before each shift. It is an integral part of the PPE electrical workers must use on the job.

Key Points:

NFPA 70E is a key resource for both employers and employees. It contains detailed instructions on PPE and safe work procedures required for specific tasks.

This standard specifically defines test equipment as part of PPE.

The NFPA 70E standard provides extensive information on what it takes to work safely, and to run an effective electrical safety program. It provides guidance on employee training, work planning and procedures (including lockout/tagout) and use of PPE. Whether you're a professional electrician, an apprentice or a supervisor, NFPA 70E is must reading. And don't forget, OSHA also refers to NFPA 70E.

ANSI sets standards for equipment

The American National Standards Institute (ANSI) also plays a role in electrical safety. This private, non-profit organization administers and coordinates the U.S. voluntary standardization and conformity assessment system. And it represents the U.S. in international standards organizations, such as the International Organization for Standardization (ISO) and the IEC.

Key Points:

Employers and technicians should be familiar with ANSI electrical safety standards C33.27-74 and S82.02 and, if applicable, C2-81.

OSHA electrical safety regulation 1910 Subpart S refers to several ANSI standards. The key ANSI standards involving electrical safety are ANSI C33.27-74 (Safety Standard for Outlet Boxes and Fittings for Use in Hazardous Locations) and ANSI S82.02 (see below), which provides important safety rules for electrical test instruments. ANSI C2-81 (National Electrical Safety Code) deals with electric installations of more than 1000 volts, an area beyond the scope of this article.

IEEE helps calculate arc flash hazard

Another authority in safety is the Institute of Electrical and Electronics Engineers. IEEE 1584^a-2002, Guide for Arc Flash Hazard Calculations, does just what its title suggests, providing technical information employers can use to determine the arc flash hazards present in the workplace. IEEE publishes a number of other useful safety standards and practice guides, including the twelve-volume IEEE Color Books^a series.

CAT (Category) IV is associated with the origin of installation. This refers to power lines at the utility connection, as well as the service entrance. It also includes outside overhead and underground cable runs, since both may be affected by lightning.

CAT III covers distribution level wiring. This includes 480-volt and 600-volt circuits such as 3-

phase bus and feeder circuits, motor control centers, load centers and distribution panels. Permanently installed loads are also classed as CAT III. CAT III includes large loads that can generate their own transients. At this level, the trend to using higher voltage levels in modern buildings has changed the picture and increased the potential hazards.

CAT II covers the receptacle circuit level and plug-in loads.

CAT I refers to protected electronic circuits.

Some installed equipment may include multiple categories. A motor drive panel, for example, may be CAT III on the 480-volt power side, and CAT I on the control side.

Key Points:

The hazard category system detailed by ANSI, CSA and IEC provides useful information for preparing against the hazards of transient voltage impulses (voltage spikes) in the environments where most industrial electricians work.

A higher CAT number refers to an electrical environment with higher power available and higher-energy transients. This is a key principle to understand when it comes to choosing and using test instruments. A multimeter designed to a CAT III standard can resist much higher energy transients than one designed to CAT II standards. Within a category, a higher voltage rating denotes a higher transient withstand rating; e.g., a CAT III-1000 V meter has superior protection compared to a CAT III-600 V rated meter.

Transient protection

The real issue for meter circuit protection is not just the maximum steady state voltage range, but a combination of both steady state and transient overvoltage withstand capability. Transient protection is vital. When transients ride on high energy circuits, they tend to be more dangerous because these circuits can deliver large currents.

If a transient causes an arcover, the high current can sustain the arc, producing a plasma breakdown or explosion, which occurs when the surrounding air becomes ionized and conductive. The result is an arc blast, a disastrous event which causes numerous injuries every year.

The concept of categories is not new and exotic. It is simply an extension of the same common-sense concepts that people who work with electricity professionally use every day. It's another tool you can use to better understand the hazards you face on the job, and work safely.

All of the regulations we have covered are built in the same way. They grow from experience, and they are based on experience and sound, common sense principles. No tool, however, can do the job alone. It's up to you, the user, to learn these safety regulations and standards, and use them effectively on the job.

After all, it's your safety at stake. Read up, and work safely.

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