"Electrical Safety in the Workplace"

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September 2008

Course Goal – *The aim of this program is to provide comprehensive on-site training to high-risk workers (i.e. skilled trades and maintenance workers) and management on the requirements of Sub Part S, and the prevention of serious injuries from electrical hazards at their worksites. Participants will develop understanding of the requirements of OSHA Sub Part "S" and NFPA, 70E and will be able to identify and reduce or eliminate electrical safety hazards in their workplace. Electrical Safe Work Practices including electrical safety principles, guidelines for qualification of personnel, job planning requirements and Management and Personal Responsibility will be covered.*

Section	Content	Objective
1	**Introduction to Electrical Safety**	Participants will be able to: • Explain the issues (statistics) associated with poor electrical safety in the workplace. • Recall key electrical terms which are essential to understanding and meeting the requirements of key electrical safety standards; i.e. OSHA 29 CFR 1910.331-.335, NFPA 70E, NEC (NFPA 70) • Define and differentiate between qualified and unqualified persons under OSHA Sub Part S. and the training requirements for each. • Describe the intent of an Electrical Safety Program and list the essential elements of an effective program. • Use a "Status Check" survey to assess the facility's electrical safety program and where necessary develop strategies for improvement.
2	**Identifying the Hazards**	Participants will be able to: • List types of electrical hazards to personnel and describe the nature of the hazards related to: o Electric shocks, arcs and blasts o Fault current and potential difference o Electrical safety in industrial plants • List the characteristics of an arc flash hazard • List the characteristics of an arc blast hazard • Explain how other injury hazards are related to shock, flash, and blast
3	**OSHA Requirements**	Participants will be able to: • Identify requirements specified in OSHA 29 CFR 1910.301-.308 and NFPA 70E-2004 Chapter 4 and describe similarities and differences in OSHA and 70E. • Explain how NFPA 70E is used in OSHA compliance and enforcement. • Determine training for workers in accordance with OSHA Sub Part S requirements. • Recall Safe Installation Practices including: o Guarding o Identification o Flexible cords and cables o System grounding o Location of overcurrent protection devices o Workspace clearance requirements • Assess an electrical installation for compliance with OSHA regulations. • Explain the reasons for doing a site assessment to determine arc flash hazard potential for equipment and electrical enclosure.
4	**Safety Related Work Practices**	Participants will be able to: • Identify requirements for electrical safe work practices specified in OSHA 29 CFR 1910.331-.335 and NFPA 70E Chapter 1 • Define an "Electrically Safe Work Condition" and list specific steps to be taken to ensure an electrically safe work condition. • Explain how the creation of an electrically safe work condition can involve hazards

		and the methods to protect against them.
		• Describe the facility's lockout/tagout (LO/TO) procedure including requirements and activities in the procedure and identify the persons responsible for each activity.
		• Determine the LO/TO procedure applicable to a given facility, operation, equipment or activity.
		• Describe other safety related work practices to protect from electrical hazards including:
		  o Selection and use of work practices
		  o De-energized work practices
		  o Energized work practices
		  o Approach boundaries and approach distances
		  o Requirements for use of test instruments and equipment
		  o Requirements for insulated tools
		  o Other equipment such as ladders, barricades, signs

5	**Working On or Near Live Parts**	Participants will be able to: • Identify persons who may be exposed to a source of electrical energy directly or indirectly. • List the conditions under which "hot work" is allowed. • Describe the purposes of an energized electrical work permit. • Recall three types of approach boundaries and define the dimensions of each approach boundary, given all necessary information. • Describe the essential parts of a Flash Hazard Analysis and list the data required analysis. • List the information, including Hazard Risk Category, provided to a worker by a Flash Hazard Analysis and describe its use.
6	**Personal Protective Equipment (PPE)**	Participants will be able to: • List the basic types of personal protective equipment (PPE) for tasks involving electrical hazards. • Describe how each type protects against hazards and identify the limitations of PPE. • Explain the need for flame resistant (FR) clothing and layering of clothing for protection and list clothing prohibited where electrical hazards are present. • Select PPE for a given Hazard Risk Category including gloves, eye, head, face protection and (FR) clothing. • Describe the requirements for use, care, maintenance and storage of PPE.
7	**Action Planning and Course Wrap-up**	Participants will be able to: • Outline an Action Plan to achieve compliance with OSHA Subpart S and NFPA 70E. • Provide assistance to help achieve workplace goals of OSHA Subpart S and NFPA 70E compliance.

AGENDA

* Denotes Electrical Hazard Awareness training sections.

Introductions

Individual Introductions:

- Your name, worksite, local union, job title and/or Union title

Introductions:

1. **How long** have you been doing electrical repairs or troubleshooting? ______________________

2. What electrical **responsibilities** do you know are **within your training**?
   1) ____
   2) ____

3. What electrical **responsibilities** do you know are **outside your training**?
   1) ____
   2) ____

4. What type of **Personal Protective Equipment (PPE)** is available to you when working on or near live electrical equipment? ____

Answer the following throughout the session --

5. What **action** does your facility need to take to comply with the revised Electrical Standards?

   <u>Sticky notes</u> are at the tables. As we cover ideas, you'll think, *"Our facility needs to do (fill in the blank) to take care of this!"* When you do, write that action on a post-it note, along with the *<u>page number that sparked it</u>*. Pile the notes in front you. They will be used in the wrap-up planning exercise.

A Checklist to Clarify Status

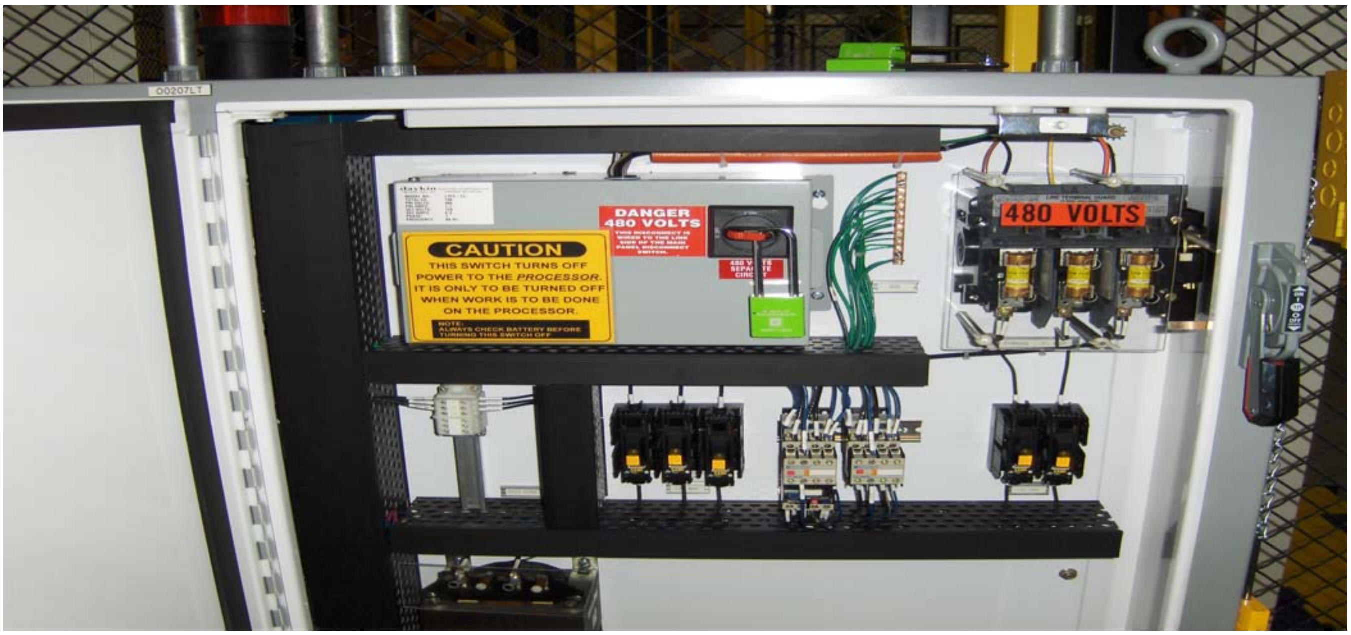
Column 1 -- Do these items describe your facility? Answer **Y**ES, **N**O, or **S**OMEWHAT

ITEM -- Each sentence starts with "Does Your Facility….."	**1**
1. …work on **50V** or more?	
2. …have all breakers and switches marked for what it goes to**?**	
3. …provide Lockout/Tagout (LOTO) training for everyone?	
4. ...provide GFI protection for extension cords and electric portable tools?	
5. …provide Flame Retardant (FR) clothing to "qualified" personnel?	
6. ...stress LOTO before doing any service or maintenance on electrical components?	
7. …inspect electrical cords on portable tools and extension cords prior to each use?	
8. …have a procedure for taking damaged cords out of service for repairs prior to use?	
9. …have all panels / Electrical Cabinets marked for voltage?	
10. ...provide "Electrical Hazard Awareness Training" for everyone?	
11. ...reset breakers with "qualified" personnel?	
12. ...have an electrical room or vault?	
13. ...is the room secured to prevent "unqualified" personnel from entering?	
14. ...use dielectric tested gloves when working on/near live electrical parts?	
15. …use insulated tools when working on/near live electrical parts?	
16. ...do Preventitive Maintenance on circuit breakers and switches at least annually?	
17. ...have 40 cal/cm2 suits available?	
18. ...have buss plugs that are changed by personnel?	
19. ...work on live electrical equipment to trouble shoot or because it can't be shut down?	
20. ...have all the incident energy calculated and Arc Flash Boundaries set for all service connections of 50V or more?	
21. …are the boundaries posted on panels/disconnects?	
22. ...use a "Hot Electrical Work Permit" system?	
23. … install new equipment or rebuild older equipment?	
24. ...keep all electrical cabinets and electrical disconnects clear (36")?	
25. … use approved electrical test devices?	
26. ...have someone trained in CPR-1st Aid and AED?	
27. …inspect PPE prior to each use?	

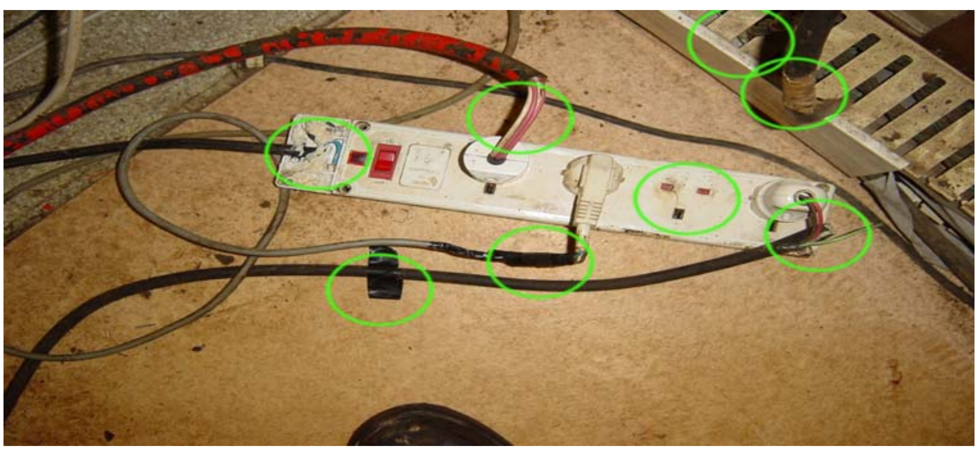
3. Circle the top 5 items that your facility most needs to improve.
4. **Next,** compare your responses to those of others in your group:
   What are the common concerns? Where are the differences? What work has to be done?

What’s wrong here? ______________________

What’s the problem?_________________



Can this cabinet be turned back on and create a hazard?____



How many hazards/violations are there in this picture? ________________.

A Little History of Electricity

600BC: Static electricity
Thales, a Greek, found that when amber was rubbed with silk it attracted feathers and other light objects. He had discovered static electricity. The Greek word for amber is elektron', from which we get electricity' and electronics'.

1600: William Gilbert invented the term electricity
William Gilbert, scientist and physician to Queen Elizabeth I, coined the term electricity. He was the first person to describe the earth's magnetic field and to realize that there is a relationship between magnetism and electricity.

1752: Franklin proved that lightning is a form of electricity
Benjamin Franklin, famous U.S. politician, flew a kite with a metal tip into a thunderstorm to prove that lightning is a form of electricity.

1820: Hans Christian Oersted discovered magnetic fields caused by electricity
Hans Christian Oersted of Denmark found that when electricity flows through a wire, it produces a magnetic field that affects the needle of a nearby compass.

1821: Michael Faraday's discovery that led to the invention of electric motors
Michael Faraday discovered that when a magnet is moved inside a coil of copper wire, a tiny electric current flows through the wire. This discovery later led to the invention of electric motors.

1826: André Ampère explained the electro-dynamic theory
André Ampère published his theories about electricity and magnetism. He was the first person to explain the electro-dynamic theory. The unit of electric current was named after Ampère.

1827: Georg Ohm published his complete mathematical theory of electricity
German college teacher Georg Ohm published his complete mathematical theory of electricity. The unit of electrical resistance was later named after him.

1831: The First Telegraph Machine
Charles Wheatstone and William Fothergill Cooke created the first telegraph machine.

1838: Samuel Morse invented Morse Code
At an exhibition in NewYork, Samuel Morse demonstrated sending 10 words a minute by his new telegraph machine. He used a system of dots and dashes, which later became standard throughout the world, known as Morse code.

1870s: Thomas Edison built a DC electric generator
Thomas Edison built a DC (direct current) electric generator in America. He later provided all of New York's electricity.

1876: Alexander Graham Bell invented the telephone
Alexander Graham Bell, inventor of the telephone, used electricity to transmit speech for the first time.

1878: Joseph Swan demonstrated the first Electric Light
Thomas Edison demonstrated the first electric light with a carbon filament lamp.

1879:
<u>First fatal accident due to electric shock.</u>

1800's: Nicola Tesla devised the AC (Alternating Current) system for electrical transmission that is used in homes, businesses and industry today. He also invented the motors that run on AC and designed the world's first Hydroelectric Plant (in Niagara Falls, NY).

1895: The first electric hand drill
The first electric hand drill became available, invented by Wilhelm Fein.

1918-19: Washing machines and refrigerators
Electric washing machines and refrigerators first became available.

1926: First National Grid was introduced
Electricity Supply Act - the first National Grid was introduced.

1930-40s: Electrical household appliances introduced
Mains powered radios, vacuum cleaners, irons and refrigerators were becoming part of every household.

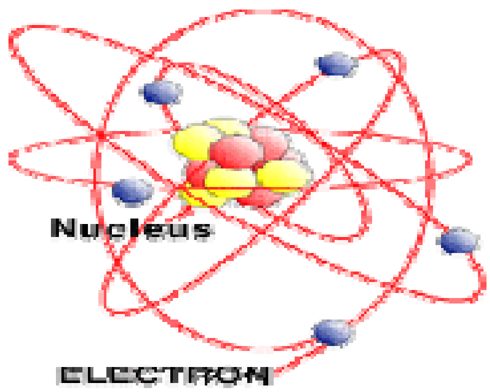
1936: John Logie Baird pioneered the television.

1752

What Is Electricity?

Electricity is everywhere in our lives. Electricity lights up our homes, cooks our food, powers our computers, television sets, and other electronic devices. Electricity (DC Current) from batteries starts our cars and makes our flashlights shine in the dark.

But what is electricity? Where does it come from? How does it work? What are the hazards? Before we understand all that, we need to know a little bit about atoms and their structure.



All matter is made up of atoms, and atoms are made up of smaller particles. The three main particles making up an atom are the proton, the neutron and the electron.

Electrons spin around the center, or nucleus. The nucleus is made up of neutrons and protons. Electrons contain a negative charge, protons a positive charge. Neutrons are neutral -- they have neither a positive nor a negative charge.

Each atom has a specific number of electrons, protons and neutrons. But no matter how many particles an atom has, the number of electrons usually needs to be the same as the number of protons. If the numbers are the same, the atom is called balanced, and it is very stable.

So, if an atom had six protons, it should also have six electrons. The element with six protons and six electrons is called carbon. Carbon is found in abundance in the sun, stars, comets, atmospheres of most planets, and the food we eat. Coal is made of carbon; so are diamonds.

Some kinds of atoms have loosely attached electrons. An atom that loses electrons has more protons than electrons and is positively charged. An atom that gains electrons has more negative particles and is negatively charged. A "charged" atom is called an "ion."

Electrons can be made to move from one atom to another. When those electrons move between the atoms, a current of electricity is created. The electrons move from one atom to another in a "flow." One electron is attached and another electron is lost.

Since all atoms want to be balanced, the atom that has been "unbalanced" will look for a free electron to fill the place of the missing one. We say that this unbalanced atom has a "positive charge" (+) because it has too many protons.

Since it got kicked off, the free electron moves around waiting for an unbalanced atom to give it a home. The free electron charge is negative, and has no proton to balance it out, so we say that it has a "negative charge" (-).

So what do positive and negative charges have to do with electricity?

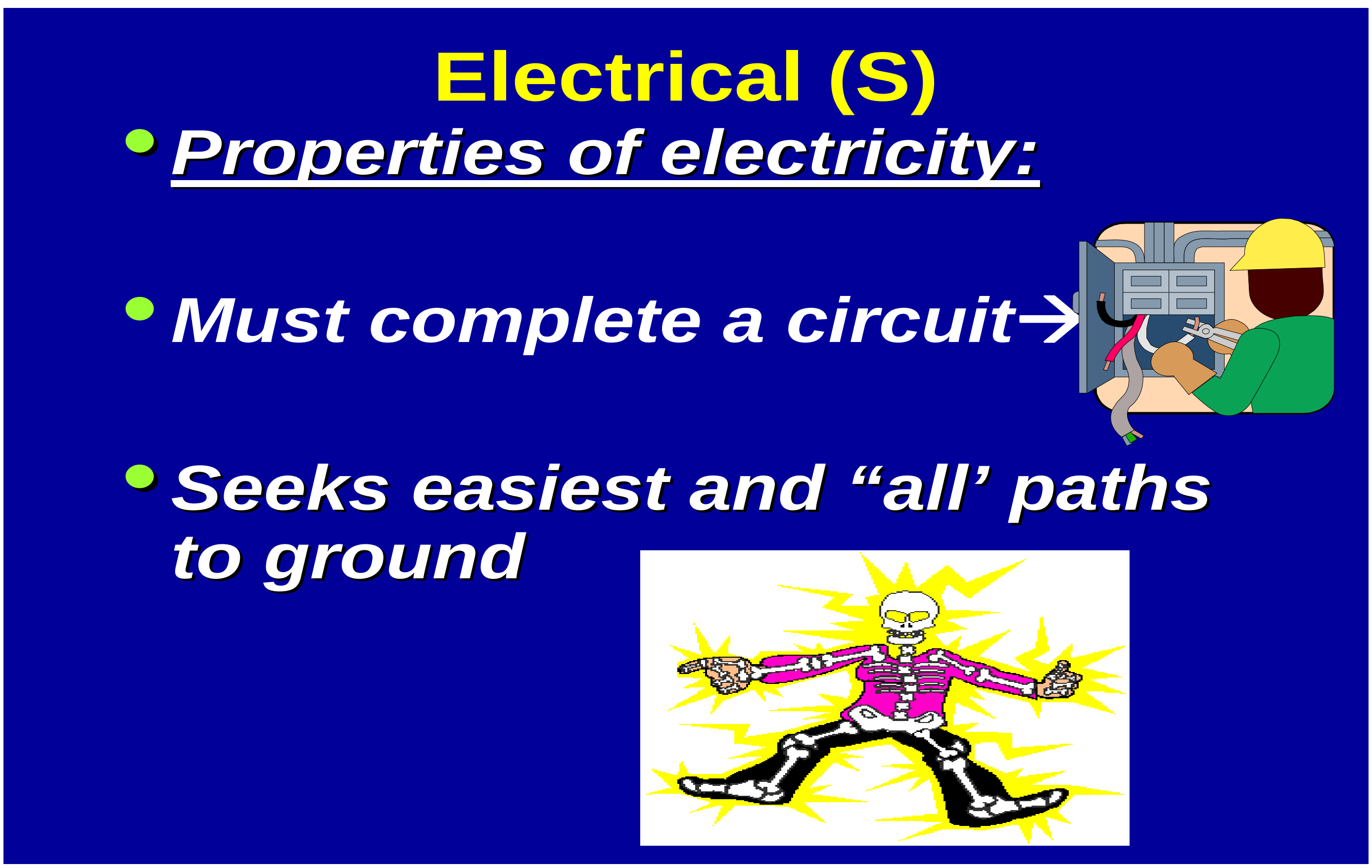
The more positive atoms or negative electrons you have, the stronger the attraction for the other. Since we have both positive and negative charged groups attracted to each other, we call the total attraction "charge."

When electrons move among the atoms of matter, a current of electricity is created. This is what happens in a piece of wire. The electrons are passed from atom to atom, creating an electrical current from one end to other.

Short definition of* "ELECTRICITY"*: is ***the flow of electrons through a conductor.***

Electricity is conducted through some materials better than others. Its resistance measures how well something conducts electricity. Some things hold their electrons very tightly. Electrons do not move through them very well. These things are called **insulators**. Rubber, plastic, cloth, glass and dry air are good insulators and have very high resistance.

Other materials have some loosely held electrons, which move through them very easily. These are called **conductors**. Most metals -- like copper, aluminum or steel -- are good conductors.



Where Does the Word 'Electricity' Come From?

Electrons, electricity, electronic and other words that begin with "electr..." all originate from the Greek word "elektor," meaning "beaming sun." In Greek, "elektron" is the word for amber.

Amber is a very pretty goldish brown "stone" that sparkles orange and yellow in sunlight. Amber is actually fossilized tree sap!

Ancient Greeks discovered that amber behaved oddly - like attracting feathers - when rubbed by fur or other objects. They didn't know what it was that caused this phenomenon. But the Greeks had discovered one of the first examples of static electricity

The Latin word, **electricus,** means to "produce from amber by friction."

The English word **electricity** is from Greek and Latin words that were about amber.

OSHA Trade News Release

Feb. 13, 2007
Contact: Elaine Fraser
Phone: (202) 693-1999

OSHA Issues Final Rule on Electrical Installation Standard

WASHINGTON -- The Occupational Safety and Health Administration will publish a final rule in tomorrow's *Federal Register* for an updated electrical installation standard.

"These are the **first changes to the electrical installation requirements in 25 years**, so it is important the standard reflects the most current practices and technologies in the industry," said Assistant Secretary for Occupational Safety and Health Edwin G. Foulke Jr. "The **revised standard strengthens employee protections and adds consistency between OSHA's requirements and many state and local building codes which have adopted updated National Fire Protection Association (NFPA) and National Electrical Code provisions**."

Changes to OSHA's general industry electrical installation standard **focus on safety in the design and installation of electric equipment in the workplace**. The updated standard includes a new alternative method for classifying and installing equipment in Class I hazardous locations; new **requirements for ground-fault circuit interrupters (GFCIs)** and new provisions on wiring for carnivals and similar installations.

The **final rule updates the general industry electrical installation requirements to the 2000 edition of the NFPA 70E, which was used as the foundation of the revised standard**. The final rule also replaces the reference to the 1971 National Electrical Code in the mandatory appendix to the powered platform standard with a reference to OSHA's electrical installation standard.

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing a safe and healthful workplace for their employees. OSHA's role is to assure the safety and health of America's working men and women by setting and enforcing standards; providing training, outreach, and education; establishing partnerships; and encouraging continual process improvement in workplace safety and health. For more information, visit www.osha.gov.

<u>Federal Register February 14, 2007</u> <u>(Action, Summary and Effective Date)</u>**:**

Department of Labor
Occupational Safety and Health Administration
29 CFR Part 1910; Electrical Standard; Final Rule

<u>ACTION:</u> Final rule.

<u>SUMMARY:</u>
The Occupational Safety and Health Administration (OSHA) is revising the general industry electrical installation standard found in Subpart S of 29 CFR Part 1910. The Agency has determined that electrical hazards in the workplace pose a significant risk of injury or death to employees, and that the requirements in the revised standard, **which draw heavily from the 2000 edition of the National Fire Protection Association's (NFPA) Electrical Safety Requirements for Employee Workplaces (NFPA 70E), and the 2002 edition of the National Electrical Code (NEC)**, are reasonably necessary to provide protection from these hazards. This final rule focuses on safety in the design and installation of electric equipment in the workplace. This revision will provide the first update of the installation requirements in the general industry electrical installation standard since 1981.

<u>DATES:</u> This final rule becomes ***effective on August 13, 2007.***

<u>Hazards Associated With Electricity</u>

Electricity is widely recognized as a **<u>serious workplace hazard</u>**, exposing employees to electric shock, burns, fires, and explosions. According to the Bureau of Labor Statistics, 250 employees were killed by contact with electric current in 2006. Other employees have been killed or injured in fires and explosions caused by electricity.

It is well known that the human body will conduct electricity. If direct body contact is made with an electrically energized part while a similar contact is made simultaneously with another conductive surface that is maintained at a different electrical potential, a current will flow, entering the body at one contact point, traversing the body, and then exiting at the other contact point, usually the ground. Each year many employees suffer pain, injuries, and death from such electric shocks.

Current through the body, even at levels as low as 3 milliamperes, can also cause injuries of an **<u>indirect or secondary</u>** injuries in which involuntary muscular reaction from the electric shock can cause bruises, bone fractures and even death resulting from collisions or falls.

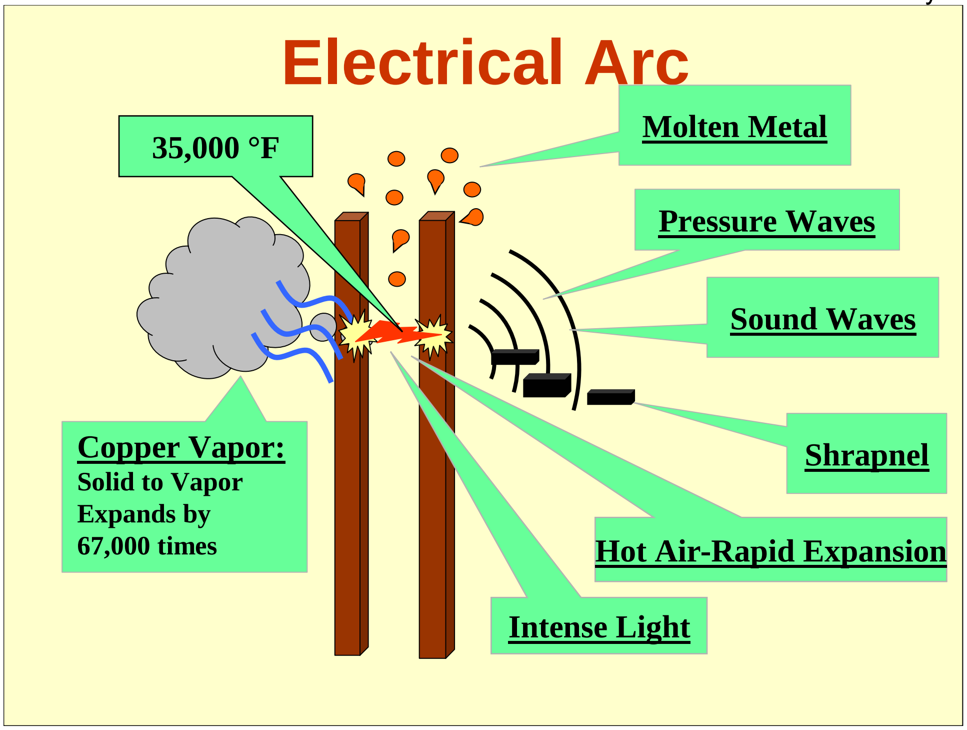
Shock

Current, Not Voltage causes Electric Shock

mA	Affect on Person
0.5 - 3	- Tingling sensations
3 - 10	- Muscle contractions and pain
→ 10 - 40	- "Let-go" threshold
30 - 75	- Respiratory paralysis
→ 100 - 200	- Ventricular fibrillation
200 - 500	- Heart clamps tight
1500 +	- Tissue and Organs start to burn

Burns suffered in electrical accidents can be very serious. These burns may be of **three basic types**: ***electrical burns, arc burns, and thermal contact burns***. **Electrical burns** are the result of the electric current flowing in the tissues, and may be either skin deep or may affect deeper layers (such as muscles and bones) or both. Tissue damage is caused by the heat generated from the current flow; if the energy delivered by the electric shock is high, the body cannot dissipate the heat, and the tissue is burned. Typically, such electrical burns are slow to heal. **Arc burns** are the result of high temperatures produced by electric arcs or by explosions close to the body. Finally, **thermal contact burns** are those normally experienced from the skin contacting hot surfaces of overheated electric conductors, conduits, or other energized equipment. In some circumstances, *all three types of burns may be produced simultaneously.*

If the current involved is great enough, electric arcs can start a fire. Fires can also be created by overheating equipment or by conductors carrying too much current. Extremely high-energy arcs can damage equipment, causing fragmented metal to fly in all directions. In atmospheres that contain explosive gases or vapors or combustible dusts, even low-energy arcs can cause violent explosions.



Nature of Electrical Accidents

Electrical accidents, when initially studied, often appear to be caused by circumstances that are varied and peculiar to the particular incidents involved. However, further consideration usually reveals the underlying cause to be a combination of **three possible factors**: work involving **unsafe equipment and installations**; workplaces made **unsafe by the environment**; and **unsafe work practice**. The *first two factors* are sometimes considered together and simply referred to as **unsafe conditions**. Thus, electrical accidents can be generally considered as being caused by unsafe conditions, unsafe work performance or, in what is usually the case, combinations of the two. It should also be noted that inadequate maintenance can cause equipment or installations that were originally considered safe to deteriorate, resulting in an unsafe condition.

Some **unsafe electric equipment and installations** can be identified, for example, by the presence of faulty insulation, improper grounding, loose connections, defective parts, ground faults in equipment, unguarded live parts, and underrated equipment. The environment can also be a contributory factor to electrical accidents in a number of ways. **Environments** containing flammable vapors, liquids, or gases; areas containing corrosive atmospheres; and wet and damp locations are some unsafe environments affecting electrical safety. Finally, **unsafe acts** include the **failure to de-energize electric equipment when it is being repaired or inspected or the use of tools or equipment too close to energized parts. (Control of Hazardous Energy – Lockout/Tagout)**

As stated earlier, electricity has long been recognized as a serious workplace hazard exposing employees to dangers such as electric shock, electrocution, fires, and explosions. The 100-year-long history of the National Electrical Code, originally formulated and periodically updated by industry consensus, attests to this fact. The NEC has represented the continuing efforts of experts in electrical safety to address these hazards and provide standards for limiting exposure in all electrical installations, including workplaces. OSHA has determined that electrical hazards in the workplace pose a significant risk of injury or death to employees and that the final rule, which draws heavily on the experience of the NEC, will substantially reduce this risk.

According to the U.S. Bureau of Labor Statistics, between 1992 and 2006, an **average of 283 employees died per year from contact with electric current**. This downward trend (See page 18) is due, in major part, to 30 years of highly protective OSHA regulation in the area of electrical installation, based on the NEC and NFPA 70E standards. The final standard carries forward most of the existing requirements for electrical installations, with the new and revised requirements intended as fine tuning, introducing new technology along with other improvements in safety. By complying with the final standard, employers will prevent unsafe electrical conditions from occurring.

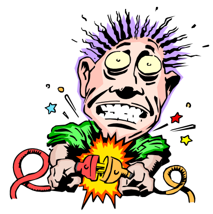
While the number of deaths and injuries associated with electrical hazards has declined, **contact with electric current still poses a significant risk** to employees in the workplace, as evidenced by the numbers of deaths and serious injuries still occurring due to contact with electric current. This final rule will help further reduce the number of deaths and injuries associated with electrical hazards by providing additional requirements for installation safety and by recognizing alternative means of compliance.

On **February 16, 1972**, *OSHA incorporated the 1971 edition of the National Fire Protection Association's (NFPA) National Electrical Code (NEC), NFPA 70-1971, by reference as its electrical standard for general industry*. The Agency followed the procedures outlined in Section 6(a) of the Occupational Safety and Health Act of 1970, which directed the Secretary to adopt existing national consensus standards as OSHA standards within 2 years of the effective date of the OSH Act. In *incorporating the 1971 NEC by reference*, OSHA made the entire 1971 NEC applicable to all covered electrical installations made after March 15, 1972. For covered installations made before that date, OSHA listed about 16 provisions from the 1971 NEC that applied.

On **January 16, 1981**, OSHA revised its electrical installation standard for general industry. This revision replaced the incorporation by reference of the 1971 NEC with relevant requirements from Part I of the 1979 edition of NFPA 70E. The revision simplified and clarified the electrical standard and updated its provisions to match the 1978 NEC (the latest edition available at the time). The standard was written to reduce the need for frequent revision and to avoid technological obsolescence. These goals were achieved--NFPA 70E had only minor changes over its initial 15 years of existence. The first substantial changes were introduced in the 1995 edition of NFPA 70E.

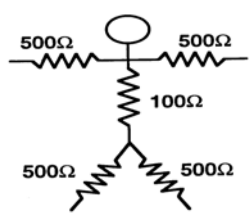
The 2000 edition of NFPA 70E contains a number of significant revisions, including a new, alternative method for classifying and installing equipment in Class I hazardous locations. NFPA has recommended that OSHA revise its general industry electrical standards to reflect the latest edition of NFPA 70E, arguing that such a revision would provide a needed update to the OSHA standards and would better protect employees. This final rule responds to NFPA's recommendations with regard to installation safety. It also reflects the Agency's commitment to update its electrical standards, keep them consistent with NFPA standards, and ensure that they appropriately protect employees. **OSHA intends to extend this commitment by using**

NFPA 70E as a basis for future revisions to its electrical safety-related work practice requirements and new requirements for electrical maintenance and special equipment.



Branch Circuits--Ground-Fault Circuit-Interrupters for Employees

Each year many employees suffer electric shocks while using portable electric tools and equipment. The nature of the injuries ranges from minor burns to electrocution. Electric shocks produced by alternating currents (ac) at power line frequency passing through the body of an average adult from hand to foot for 1 second can cause various effects, starting from a condition of being barely perceptible at 1 milliampere to loss of voluntary muscular control for currents from 9 to 25 milliamperes. The passage of still higher currents, from 75 milliamperes to 4 amperes, can produce ventricular fibrillation of the heart; and, finally, immediate cardiac arrest at over 4 amperes. These injuries occur when employees contact electrically energized parts. Typically, the frame of a tool becomes accidentally energized because of an electrical fault (known as a ground fault) that provides a conductive path to the tool casing. For instance, with a grounded electric supply system, when the employee contacts the tool casing, the fault current takes a path through the employee to an electrically grounded object. The amount of current that flows through an employee depends, primarily, upon the resistance of the fault path within the tool, the resistance of the path through the employee's body, and the resistance of the paths, both line side and ground side, from the employee back to the electric power supply. Moisture in the atmosphere can contribute to the electrical fault by enhancing both the conductive path within the tool and the external ground path back to the electric power supply. Dry skin can have a resistance range of anywhere from about 500 to 500,000 ohms and wet skin can have a resistance range of about 200 to 20,000, depending on several factors, such as the physical characteristics and mass of the employee. More current will flow if the employee is perspiring or becomes wet because of environmental conditions. If the current is high enough, the employee will suffer a ground-fault electrocution.



- **Hand to Hand Resistance = 1000W**
  - Common voltage is 120 Volts
  - Ohm's Law: I = E/R
  - **120**/1000 = .12 Amps
  - (**480**/1000= .48 Amps)

(See page 14 for "Affect on Persons")

One method of protection against injuries from electric shock is the ground-fault circuit-interrupter (GFCI). This device continually monitors the current flow to and from electric equipment. If the current going out to the protected equipment differs by approximately 0.005 amperes (5-milliamperes) from the current returning, then the GFCI will de-energize the equipment within as little as 25 milliseconds, quickly enough to prevent electrocution.

GFCI requirements. **Paragraph (b)(3) of final Sec. 1910.304** sets new requirements for ground-fault circuit-interrupter protection of receptacles and cord connectors used in general industry. **Paragraph (b)(3)(i) requires ground-fault circuit protection** for all 125-volt, single-phase, 15- and 20-ampere receptacles installed in bathrooms and on rooftops. This provision only **applies to installations made after the effective date of the final rule**. Cord sets and cord- and plug-connected equipment in these locations can get wet and expose employees to severe ground-fault hazards. The NFPA 70E Technical Committee believes, and OSHA agrees, that using 125-volt, 15- and 20-ampere cord- and plug-connected equipment in these locations exposes employees to great enough risk of ground-fault electrocution to warrant the protection afforded by GFCIs.

To determine the extent to which the standard may reduce the number of deaths attributable to electrical accidents, OSHA examined its accident investigation reports for the States without any statewide electrical code. The accident cause can be used to ascertain whether the death would have been prevented by compliance with the final rule. As an initial screen, OSHA reviewed the reports for accidents that could have been prevented through the use of a GFCI. While OSHA expects that other provisions of the revised standard potentially will reduce deaths due to electrical accidents, this initial screen focused on GFCI-related accidents since they are relatively easy to isolate using a key word search through all reports. Thus, the accident report analysis is conservative in the sense that it likely understates the number of deaths preventable under the revision to Subpart S.

Fatal Injuries Attributable To Contact With Electric Current (Private Industry)

Year	Deaths	% Total Deaths
1992..................................	317	5.8
1993..................................	303	5.4
1994..................................	332	5.6
1995..................................	327	6.0
1996..................................	268	4.8
1997..................................	282	5.0
1998..................................	324	5.9
1999..................................	259	4.7
2000..................................	256	4.8
2001..................................	285	4.8
2002..................................	289	5.2
2003..................................	246	4.4
2004..................................	254	4.4
2005…………………………	251	4.3
2006…………………………	250	4.2
2007…………………………	212 (**P**)	3.8 (**P**)

(P) Preliminary-Sept 2008

Source: U.S. Bureau of Labor Statistics, Survey of Occupational Injuries and Illnesses and the Census of Fatal

UAW - Electrical Fatalities (1973 – September, 2008)

1. **April 7, 1973 – Ralph Redmond; Chrysler – Hamtramck Assembly Plant**, 1 year seniority; **Electrician** (Apprentice) Electrical explosion and fire in electrical tunnel.

2. **October 1, 1975 – Larry Fights; GE Springdale Aircraft Engine Plant;** electrocuted

3. **July 1, 1976 – Philip Ziglar; Chrysler New Castle Machining; Pipe Fitter;** Electrocuted by energized Ignition tube.

4. **July 27, 1977 – Steve Repasy; GM-Danville Foundry; Pattern Maker** 31 years seniority; Electrocuted by energized 440-volt damaged power supply cable**.**

5. **August 9, 1977 – Dale Myers; Lindell Drop Forge; Electrician;** Electrocuted when he completed live path to ground.

6. **April 5, 1978 – Paul Caraway; 1 year seniority; GMAD Leeds; Electrician;** Electrocuted when cutting through a live cable.

7. **April 9, 1978 – Albert Kish; Ford-Woodhaven Stamping; Electrician;** Electrocuted when working on energized equipment.

8. **July 18, 1979 – E. Marcon; GM-Windsor Trim Palnt; Machine Repair; 14 years seniority;** Electrocuted when he completed the circuit between two electrical connections.

9. **July 27, 1979 – Charles Walters; Fiat Allis-Springfield Plant; Scrap Operator;** Electrocuted when he touched an ungrounded protable electric welder.

10. **May 9, 1980 – Victor Ellul; GM-Fisher Body Fleetwood; Bricklayer; 27 years seniority;** Electrocuted when he provided electrical path between energized fence and building column.

11. **June 20, 1980 – Donald Williams; Chrysler-Warren Stamping; 12 years seniority; Electrician;** Electrocuted when working inside live control panel – Not locked out.

12. **July 11, 1980 – Howard Londberg; GM-Spring and Bumper; 18 years seniority; Electrician;** Electrocuted when working on live equipment – Not locked out.

13. **January 14, 1981 – Morton Petri, GM-Detroit Diesel Allison; 3 years seniority; Machine Operator;** Electrocuted when contacting live power rail and completing circuit.

14. **August 7, 1981 – Ernest Williams; Dongan Electric Manufacturing; 1 year seniority; Heavy Duty Builder;** Electrocuted testing 45 KVA Transformer.

15. **August 24, 1981 – David Johnson; Chrysler Machining; 12 years seniority; Electrician;** Electrocuted when contacting the circuits inside a panel – Not locked out.

16. **September 22, 1981 – Steve Scherk; GE-Evendale; Lab Technician;** Electrocuted by exposed live electrical parts of forming press.

17. **September 11, 1982 – James Campoli; GM-Detroit Diesel Allison; 16 years seniority; Electrician;** Electrocuted by high voltage source in laser cabinet.

18. **December 1, 1982 - Erbin Lipp; Sunstrand Aviation; Electrician;** Electrocuted by energized electrical circuits.

19. **September 7, 1983 – Mark Michalowski; GM Detroit Fleetwood; 7 years seniority; Electrician;** Electrocuted when working on live circuit – Not locked out.

20. **December 8, 1983 – James Campbell; Ford Atlanta Assembly; 15 years seniority; Electrician;** Electrocuted by stored energy in ignition tube.

21. **July 26, 1984 - Dimosthenis Kofsandis**; 43 years old; Maintenance worker; **U.S. Auto Radiator Corporation,** Detroit, Michigan; **LU. 351; Region 1**; Electrocuted when hanging energized light fixture - not locked out.

22. **April 16, 1993**; Harry Prater; 56 years old; Seniority May 13, 1968; *Electrician*; **Ford Motor Company**, Saline, Michigan; Region 1A, LU.892; Electrocuted while troubleshooting overhead crane trolley controls with power on.

23. **April 20, 1996 - Eddie McCorkle**; 37 years old; Electrician (S/T); 3 years seniority; **National Castings Company**; Melrose Park, Illinois; **LU.477 (Unit 81); Region 4;** Electrocuted while tightening connections on an energized 13,500 volts transformer.

24. **August 27, 1996- Michael J. Perry:** 46 years old: Electrician; 7 years seniority; **Harvard Industries**; Tiffin, OH; **LU 1644, Region 2-B**; Electrocuted while working on an electrical sub-station located outside of the plant.

25. **November 1, 1997 – Paul Robel;** 49 years old; Electrician (S/T); 1 year seniority; **General Motors Corporation, SPO Lansing**; Lansing, Mi.; **LU 1753, Region 1C**; The victim was in a lift a loft 15 feet above the floor preparing to install a buss plug. After removing an access cover an electrical explosion occurred severely burning the victim. He died 16 days later.

26. **November 7, 2003** – **Concepcion Rodriguez; 55** years old: Arc Wash Welder; 16 years seniority; **Chicago Castings**; Cicero, Illinois; **Local 477, Region 4**. The victim was electrocuted while attempting to turn on a welding machine with the breaker switch mounted on the side of the equipment. Operators had experienced shocks from the equipment previously and maintenance had performed work on the equipment the previous day.

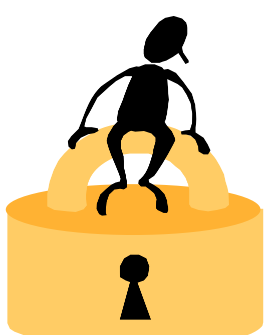
27. **January 8, 2008 – William D. LaVanway** (died 2-4-08)**: 54** years old; Electrician; 14 years seniority; **Robert Bosch Corp. Chassis Systems;** St. Joseph, Michigan; **LU 383, Region 1D**. The victim was assigned to investigate a "hot spot" found by thermograph scans on a power distribution panelboard in Dept. 48. He was working on a fusible switch bucket to determine the problem in the fuse block. The victim followed established procedures placing the disconnect switch in the off position prior to opening the bucket door and tested to verify power was off to both the load side and line side of the fuse block. The fusible switch bucket is an older design which does not have visible switch blades for positive identification of their position. He was using a screw driver to demonstrate to his supervisor that the fuse clip had good compression and was not loose when an arc fault explosion occurred.

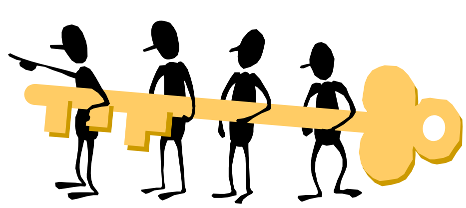
<u>Job Classifications of UAW "Electrical Fatalities":</u>

- 16 were Electricians
- 5 were Operators
- 6 were other maintenance

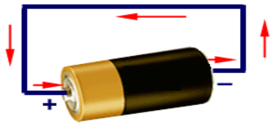
<u>Summary of events causing fatalites:</u>

- 5 objects/equipment "not grounded"
- 1 Stored electrical energy
- 3 Arc Flash
- 18 during service/maintenance – "Energy **not** disconnected, **locked out** and verified"





Circuits:

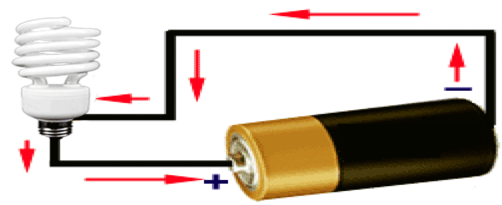

A simple circuit

Electrons with a negative charge, can't "jump" through the air to a positively charged atom. They have to wait until there is a link or bridge between the negative area and the positive area. We usually call this bridge a "circuit."

When a bridge is created, the electrons begin moving quickly. Depending on the resistance of the material making up the bridge, they try to get across as fast as they can. If you're not careful, too many electrons can go across at one time and destroy the "bridge" or the circuit, in the process.

We can limit the number of electrons crossing over the "circuit," by letting only a certain number through at a time. And we can make electricity do something for us while they are on their way. For example, we can "make" the electrons "heat" a filament in a bulb, causing it to glow and give off light.

When we limit the number of electrons that can cross over our circuit, we say we are giving it "resistance". We "resist" letting all the electrons through. This works something like a tollbooth on a freeway bridge. Copper wire is just one type of bridge we use in circuits.

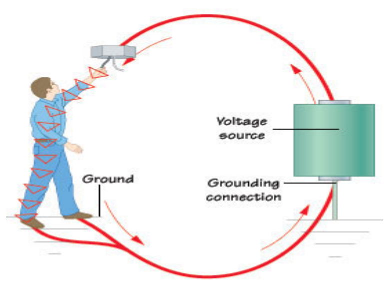

Simple circuit with light

Before electrons can move far, however, they can collide with one of the atoms along the way. This slows them down or even reverses their direction. As a result, they lose energy to the atoms. This energy appears as heat, and the scattering is a resistance to the current.

Think of the bridge as a garden hose. The current of electricity is the water flowing in the hose and the water pressure is the voltage of a circuit. The diameter of the hose is the determining factor for the resistance.

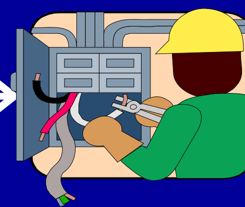
Current refers to the movement of charges. In an electrical circuit - electrons move from the negative pole to the positive. If you connected the positive pole of an electrical source to the negative pole, you create a circuit. This charge changes into electrical energy when the poles are connected in a circuit -- similar to connecting the two poles on opposite ends of a battery.

Along the circuit you can have a light bulb and an on-off switch. The light bulb changes the electrical energy into light and heat energy.

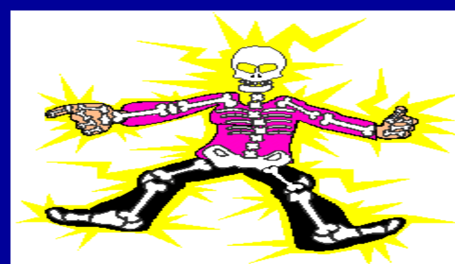


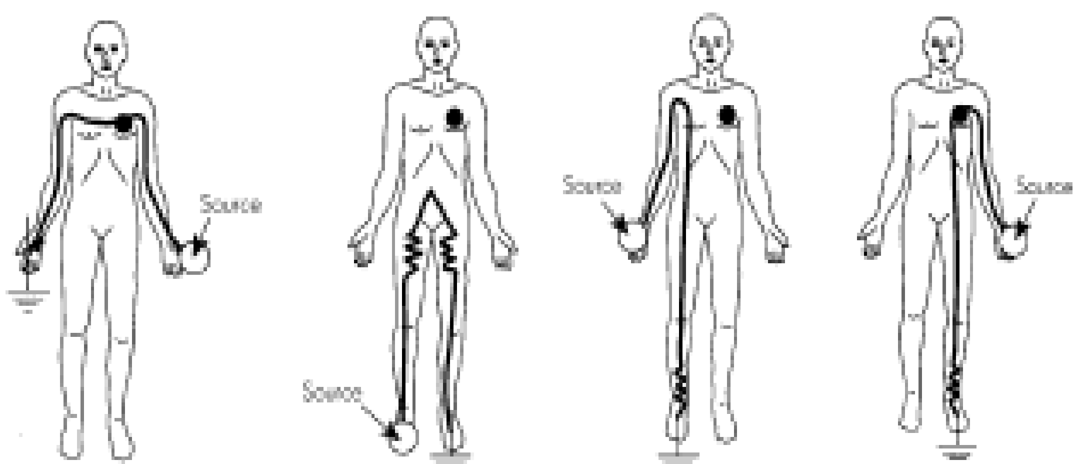
Electrical (S)

- ***Properties of electricity:***
- ***Must complete a circuit→***



- ***Seeks easiest and "all' paths to ground***





The number of electrons we are willing to let across the circuit at one time is called "current". We measure current using amperes, or "Amps".

One AMP is defined as 625,000,000,000,000,000,000 (6.25×10^{18}) electrons moving across your circuit every second!

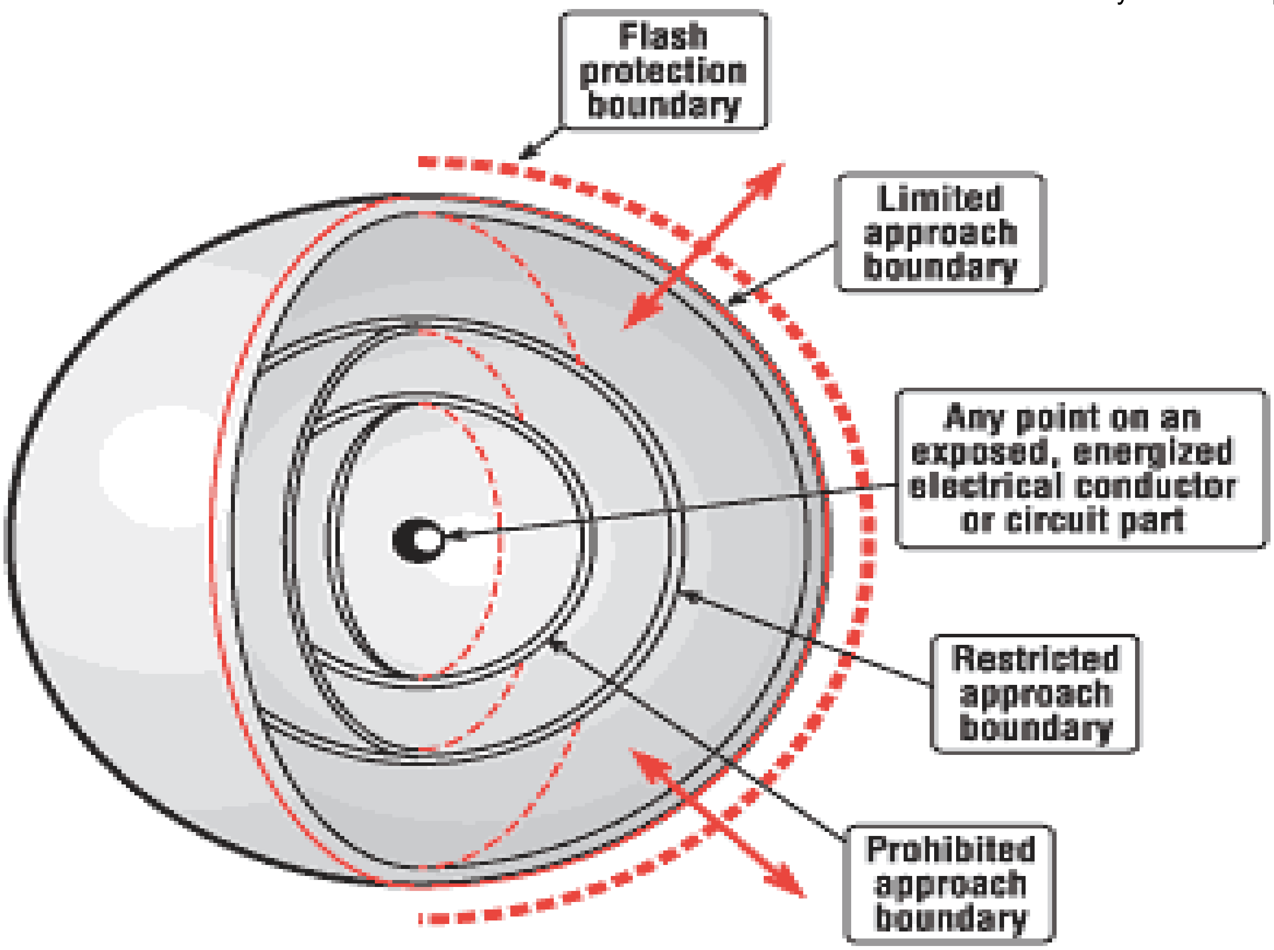
Since no one wants to remember such a big number, that big number is called a "coulomb," after the scientist Charles A Coulomb who helped discover what a current of electricity is.

The amount of charge between the sides of the circuit is called "voltage." We measure Voltage in Volts. The word **volt** is named after another scientist, Alexader Volta, who built the world's first battery.

Voltage, Current and Resistance are very important to circuits. If either voltage or current is too big you could break the circuit. But if either is too small, the circuit will not be able to work enough to be useful to us. In the same way, if the resistance is too big none of the electrons would be able to get though at all, but if it were too small, they would rush though all at once breaking the circuit on their way.

Table 130.2(C) Approach Boundaries to Live Parts for Shock Protection. (All dimensions are distance from live part to employee.)

(1)	(2) Limited Approach Boundary[1]	(3)	(4)	(5)
Nominal System Voltage Range, Phase to Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	Restricted Approach Boundary[1]; Includes Inadvertent Movement Adder	Prohibited Approach Boundary[1]
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	Avoid contact	Avoid contact
301 to 750	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	304.8 mm (1 ft 0 in.)	25.4 mm (0 ft 1 in.)
751 to 15 kV	3.05 m (10 ft 0 in.)	1.53 m (5 ft 0 in.)	660.4 mm (2 ft 2 in.)	177.8 mm (0 ft 7 in.)
15.1 kV to 36 kV	3.05 m (10 ft 0 in.)	1.83 m (6 ft 0 in.)	787.4 mm (2 ft 7 in.)	254 mm (0 ft 10 in.)
36.1 kV to 46 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	838.2 mm (2 ft 9 in.)	431.8 mm (1 ft 5 in.)
46.1 kV to 72.5 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	965.2 mm (3 ft 2 in.)	635 mm (2 ft 1 in.)
72.6 kV to 121 kV	3.25 m (10 ft 8 in.)	2.44 m (8 ft 0 in.)	991 mm (3 ft 3 in.)	812.8 mm (2 ft 8 in.)
138 kV to 145 kV	3.36 m (11 ft 0 in.)	3.05 m (10 ft 0 in.)	1.093 m (3 ft 7 in.)	939.8 mm (3 ft 1 in.)
161 kV to 169 kV	3.56 m (11 ft 8 in.)	3.56 m (11 ft 8 in.)	1.22 m (4 ft 0 in.)	1.07 m (3 ft 6 in.)
230 kV to 242 kV	3.97 m (13 ft 0 in.)	3.97 m (13 ft 0 in.)	1.6 m (5 ft 3 in.)	1.45 m (4 ft 9 in.)
345 kV to 362 kV	4.68 m (15 ft 4 in.)	4.68 m (15 ft 4 in.)	2.59 m (8 ft 6 in.)	2.44 m (8 ft 0 in.)
500 kV to 550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.43 m (11 ft 3 in.)	3.28 m (10 ft 9 in.)
765 kV to 800 kV	7.24 m (23 ft 9 in.)	7.24 m (23 ft 9 in.)	4.55 m (14 ft 11 in.)	4.4 m (14 ft 5 in.)



This illustration shows the relationship between Shock/Arc Flash boundaries and the part to be serviced.
Note: The Flash Protection Boundary could be more than or less than the Shock-Limited Approach Boundary.

OSHA Electrical Sub Part "S" and NFPA 70E

OSHA = "Shall" & NFPA 70E = "How"

Sample 5A001 (General Duty) Citations:

Standard Cited: 5A0001

Violation Items		
Nr: 305434243	Citation: 01001	ReportingID: 0522500
Viol Type: Serious	NrInstances: 1	Contest Date:
	Nr Exposed: 20	Final Order:
Initial Penalty: 4500.00	REC:	Emphasis:
Current Penalty: 4275.00	Gravity: 10	Haz Category: ELECTRIC
Substance: 8870 Electrical Shock		

Type	Event	Date	Penalty	Type
Penalty	Z: Issued	07/16/2003	4500.00	Serious
Penalty	I: Informal Settlement	07/30/2003	4275.00	Serious

Text For Citation: 01 **Item/Group:** 001 **Hazard:** ELECTRIC

Section 5(a)(1) of the Occupational Safety and Health Act of 1970: The employer did not furnish employment and a place of employment which were free from recognized hazards that were causing or likely to cause death or serious physical harm to employees in that employees were exposed to: a. Maintenance employees who routinely perform tasks such as compressor PM's (amperage draws), checking voltages at fuses and contacts, replacing fuses, replacing breakers, troubleshooting motors and checking power feed lines from bus lines were exposed to potential electrical hazards such as shock, burn, electrocution, arc flash, and arc blast, while working on energized electrical systems of up to 480 Volts. The **employees did not wear all necessary electrical personal protective equipment** such as face shields, safety glasses, and were not utilizing all the necessary specialized tools, barriers , shields or insulating materials to protect against all potential electrical hazards. **No adequate hazard analysis (such as a flash hazard analysis as described in NFPA 70E** ("Standard for Electrical Safety Requirements for Employee Workplaces" **(2000 Edition)** Section 2-1.3.3)) had been conducted to determine whether the potential hazards of the work to be performed (such as shock, electrocution, arc blast, and arc flash) warranted the use of any, or all such personal protective equipment, specialized tools, barriers, shields or insulating materials. Feasible means of abatement can be achieved by conducting a Flash Hazard Analysis in accordance with NFPA 70E Section 2-1.3.3 (or its equivalent) and providing for, and requiring, the use of the necessary personal protective equipment as determined following that analysis.

Standard Cited: 5A0001

Violation Items		
Nr: 307995217	Citation: 01001A	ReportingID: 0524200
Viol Type: Other	NrInstances: 2	
	Nr Exposed: 4	
Initial Penalty: 3500.00	REC:	Emphasis:
Current Penalty: 3500.00	Gravity: 10	Haz Category: ELECTRIC

Type	Event	Penalty	Type
Penalty	Z: Issued	3500.00	Serious
Penalty	F: Formal Settlement	3500.00	Other

Text For Citation: 01 Item/Group: 001A Hazard: ELECTRIC
Section 5(a)(1) of the Occupational Safety and Health Act of 1970: The employer did not furnish employment and a place of employment which were free from recognized hazards that were causing or likely to cause death or serious physical harm to employees in that employees were exposed to electrical hazards: a) On or about May 21, 2004 and July 12, 2004, Windy City Electric Company **did not ensure the de-energization of live parts prior to the performance of work** on 480V Switchgear at O'Hare International Airport. Among others, one feasible and acceptable means of abatement would be to comply with **the 2004 Edition of the National Fire Protection Association (NFPA) 70E, Standard for Electrical Safety in the Workplace**, Article 130, Working On or Near Live Parts, Section 130.1. No abatement certification or documentation required for this item.

Excerpts from "The OSHA Act" (General Duty - 5A0001) is:

SEC. 5. Duties

(a) Each employer --

(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;

(2) shall comply with occupational safety and health standards promulgated under this Act.

(b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

Excerpt from OSHA Letter of Interpretation #1:

Question (2): *I note that OSHA has not incorporated the personal protective equipment portions of NFPA 70E by reference in 1910.132 (personal protective equipment, general requirements) or 1910.335 (safeguards for personal protection). Does an employer have an obligation under the General Duty Clause to ensure that its own employees comply with personal protective equipment requirements in NFPA 70E?*

Answer

These provisions are written in general terms, requiring, for example, that personal protective equipment be provided "where necessary by reason of hazards..." (1910.132(a)), and requiring the employer to select equipment "that will protect the affected employee from the hazards...." (1910.132(d)(1)). Also, 1910.132(c) requires the equipment to "be of safe design and construction for the work performed."

Similarly, 1910.335 contains requirements such as the provision and use of "electrical protective equipment that is appropriate for the specific parts of the body to be protected and the work to be performed (1910.335(a)(i)).

Industry consensus standards, such as **NFPA 70E, can be used by employers as guides to making the assessments and equipment selections** required by the standard. Similarly, in OSHA enforcement actions, they can be used as evidence of whether the employer acted reasonably.

Under 1910.135, the employer must ensure that affected employees wear a protective helmet that meets either the applicable ANSI Z89.1 standard or a helmet that the employer demonstrates "to be equally effective." If an employer demonstrated that NFPA 70E contains criteria for protective helmets regarding protection against falling objects and electrical shock that is equal to or more stringent than the applicable ANSI Z89.1 standard, and a helmet met the NFPA 70E criteria, the employer could use that to demonstrate that the helmet is "equally effective."

Question (5): *How can I distinguish between electrical work that is considered "construction work" and electrical work that is considered "general industry work"?*

Answer

29 CFR 1910.12 sets out the scope of OSHA construction standards.

Section 1910.12(a) provides that:

The standards prescribed in part 1926 of this chapter … shall apply … to every employment and place of employment of every employee engaged in construction work.

Section 1910.12(b) defines construction work as follows:
Construction work means work for construction, alteration, and/or repair, including painting and decorating.

Excerpt from OSHA Letter of Interpretation #2:

November 14, 2006

ORC Worldwide
Sunderland Place, NW
Washington, DC 20036

Dear Ms. Linhard:

Thank you for your e-mail to the Occupational Safety and Health Administration's (OSHA's) Directorate of Enforcement Programs (DEP) for an interpretation regarding OSHA's requirements and the National Fire Protection Association's (NFPA) 70E-2004, *Standard for Electrical Safety in the Workplace*. Your questions have been restated below for clarity. We apologize for the delay in our response.

Question 1: When work must be performed on energized electric equipment that is capable of exposing employees to arc-flash hazards, does OSHA require the marking of the electric equipment to warn qualified persons of potential electric arc-flash hazards — i.e., as required by NFPA 70E-2004?

Reply: OSHA has no specific requirement for such marking. A requirement to mark equipment with flash hazard warnings was not included in the 1981 Subpart S revision. **However**, **paragraph (e) of 1910.303** requires employers to mark electrical equipment with descriptive markings, including the equipment's voltage, current, wattage, or other ratings as necessary. OSHA believes that this information, along with the training requirements for qualified persons, will provide employees the necessary information to protect themselves from arc-flash hazards.

Additionally, in 1910.335(b), OSHA requires employers to use alerting techniques (safety signs and tags, barricades, and attendants) *. . . to warn and protect employees from hazards which could cause injury due to electric shock, burns or failure of electric equipment parts*. **Although these Subpart S electrical provisions do not specifically require that electric equipment be marked to warn qualified persons of arc-flash hazards, 1910.335(b)(1) requires the use of safety signs, safety symbols, or accident prevention tags to warn employees about electrical hazards (e.g., electric-arc-flash hazards**) which may endanger them as required by 1910.145.

Question 2: Is flame-resistant clothing required for employees working on electrical installations covered by Subpart S?

Reply: **Arc-flash hazards are addressed in the OSHA electrical safety-related work practices standards**. For example, **with respect to arc-flash burn hazard** prevention, the general provisions for the *Selection and use of work practices* contained in 1910.333(a)(1) generally require de-energization of live parts before an employee works on or near them — i.e., **employees must first render electric equipment safe by completely de-energizing it by means of lockout and tagging procedures.** This single safe work practice significantly reduces the likelihood of arc-flash burn injury by reducing employee exposure to electrical hazards — i.e., exposure is limited to when the equipment is shut down and when the qualified employee verifies, by use of a test instrument, a de-energized state.

When employees perform work **on energized circuits, as permitted by 1910.333(a)(1), tools and handling equipment that might make contact with exposed energized parts must be insulated in accordance with 1910.335(a)(2)(i). This work practice also reduces the likelihood of employee injury caused by an arc blast**.

Arc-flash hazards are also addressed in 1910.335(a)(1)(v), *Safeguards for personnel protection*, which requires that personal protective Equipment (PPE) for the eyes and face be worn whenever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from an electrical explosion. In addition, paragraph (a)(2)(ii) of 1910.335 requires, in pertinent part, the use of protective shields, barriers, or insulating equipment "to protect each employee from shocks, burns, or other electrically related injuries while that employee is working *. . . where* ***dangerous electric heating or arcing might occur***" . The 1910.335(a)(2)(ii) safeguard selected — shield, barrier, or insulating material — **must fully protect employees** from electric shock, the blast, and arc-flash burn hazards associated with the incident energy exposure for the specific task to be performed. However, in situations where a fully protective safeguard could be used as an alternative, OSHA will, under its policy for *de minimis* violations, allow employers to use, instead, safeguards that are not fully protective, provided that the employer implement additional measures. The supplemental measures, which could include the use of arc-rated FR clothing appropriate to the specific task, must fully protect the employee from all residual hazardous energy (e.g., the resultant thermal effects from the electric arc) that passes the initial safeguard.

OSHA recommends that employers consult consensus standards such as NFPA 70E-2004 to identify safety measures that can be used to comply with or supplement the requirements of OSHA's standards for preventing or protecting against arc-flash hazards. For example, Section 130.3 of the NFPA standard establishes its own mandatory provisions for flash-hazard-analysis, which sets forth the criteria to define a flash-protection boundary and the personal protective equipment for use by employees within the flash-protection boundary. The goal of this provision is to reduce the possibility of being injured by an arc-flash. The analysis is task specific and determines the worker's incident-energy exposure (in calories per square centimeter). Where it has been determined that work will be performed within the flash-protection boundary, NFPA 70E specifies that flame-resistant clothing and PPE use either be based on the pre-determined incident-energy exposure data or be in accordance with the *Hazard/Risk Category Classifications* and *Protective Clothing and Personal Protective equipment (PPE) Matrix* tables contained in Sections 130.7(C)(9) and (C)(10), respectively.

Other NFPA 70E, Article 130 provisions, such as the justification for work through the use of an energized electrical work authorization permit, and the completion of a job briefing with employees before they start each job, additionally decrease the likelihood that exposure to electrical hazards would occur.

Question 3: How is OSHA enforcing 1910.132 and Subpart S with regard to the latest edition of NFPA 70E requirements?

Reply: Industry consensus standards, such as NFPA 70E, can be used by OSHA and employers as guides in making hazard analyses and selecting control measures.

With regards to enforcing 1910.132 and the Subpart S standards, the PPE requirements contained in Subpart S would prevail over the general requirements contained in 1910.132 where both standards would apply to the same condition, practice, control method, etc.

Question 4: Does OSHA issue Section 5(a)(1) General Duty Clause violations to companies who do not follow the new NFPA 70E requirements?

Reply: A violation of the General Duty Clause, Section 5(a)(1) of the Act, exists if an employer has failed to furnish a workplace that is free from recognized hazards causing or likely to cause death or serious physical injury. The General Duty Clause is not used to enforce the provisions of consensus standards, although such standards are sometimes used as evidence of hazard recognition and the availability of feasible means of abatement. In addition, the General Duty Clause usually should not be used if there is a standard that applies to the particular condition, practice, means, operation, or process involved.

Thank you for your interest in occupational safety and health. We hope you find this information helpful. OSHA requirements are set by statute, standards, and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. In addition, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at http://www.osha.gov. If you have any further questions, please feel free to contact the Office of General Industry Enforcement at (202) 693-1850.

Sincerely,
Edwin G. Foulke, Jr.

(Footnotes in November 14, 2006 Letter of Interpretation)

- Section 400.11 of NFPA 70E-2004 states: *Switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.*

- OSHA has not formally compared each provision of the NFPA 70E-2004 standard with the parallel provision in Subpart S but generally believes that the NFPA standard offers useful guidance for employers and employees attempting to control electrical hazards. The Agency notes, however, that the face and head protection requirements contained in the NFPA 70E Section 130.7(c)(10) Table do not require face and head area protection for Hazard Risk Category 1, even when serious face and head injury from the thermal effects of the arc could result. Therefore, this particular NFPA provision may not provide equivalent or greater employee protection with respect to the corresponding OSHA standards on eye, face, and head protection — i.e., 1910.335(a)(1)(iv) and 1910.335(a)(1)(v). In addition, the Individual Qualified Employee Control Procedure conditionally permits certain work activities to be performed without the placement of lockout/tagout devices on the disconnecting means. This work practice provides less employee protection than that afforded by compliance with the OSHA lockout and tagging requirements contained in 1910.333(b)(2) and is, therefore, not acceptable.

- When an employee is working within the flash-protection boundary, Section 130.7 of the NFPA 70E-2004 standard requires the employee to wear protective clothing wherever there is possible exposure to an electric **arc flash above the threshold incident-energy level for a second-degree burn**, 5 J/cm^2 (1.2) cal/cm^2. In other words, the protective clothing system is designed to protect the employee from receiving second or third-degree burns to his or her body. The typical characteristics, degree of protection, and required minimum arc ratings for typical protective clothing systems may be found in NFPA 70E Table - 130.7(c)(11).

Skin Temperature	Duration	Damaged Caused
110 F	6.0 hours	Cell breakdown begins
158 F	1.0 second	Total cell destruction
176 F	0.1 second	Curable (second-degree) burn (1.2 cal/cm2)
205 F	0.1 second	Incurable (third-degree) burn

Table 130.7(C)(11) Protective Clothing Characteristics

Typical Protective Clothing Systems

Hazard/Risk Category	Clothing Description (Typical number of clothing layers is given in parantheses)	Required Minimum Arc Rating of PPE [J/cm2(cal/cm2)]
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd2 (1)	N/A
1	FR shirt and FR pants or FR coverall (1)	16.74 (4)
2	Cotton Underwear -- conventional short sleeve and brief/shorts, **plus** FR shirt and FR pants (1 or 2)	33.47 (8)
3	Cotton Underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear **plus** two FR coveralls (2 or 3)	104.6 (25)
4	Cotton Underwear plus FR shirt and FR pants **plus** multilayer flash suit (3 or more)	167.36 (40)

The NFPA 70E standard requires the protective clothing selected for the corresponding hazard/risk category number to have an arc rating of at least the minimum value listed.

OSHA Directives

STD 01-16-007 - STD 1-16.7 - Electrical Safety-Related Work Practices -- *Inspection Procedures and Interpretation Guidelines*

A. Purpose.

This instruction establishes policies and provides interpretive guidelines to ensure uniform enforcement of the standard for Electrical Safety-Related Work Practices, 29 CFR 1910.331 through .335.

B. Scope.

This instruction applies OSHA-wide.

C. References

1. OSHA Instruction STD 1-7.3, September 11, 1990, 29 CFR 1910.147, the Control of Hazardous Energy (Lockout/Tagout)--Inspection Procedures and Interpretive Guidance.
2. General Industry Standards, 29 CFR 1910, Subpart S.
3. OSHA Instruction CPL 2.45B, June 15, 1989, the Revised Field Operations Manual.
4. NFPA 70E, 1983, Electrical Safety Requirements for Employee Workplaces.

D. Effective Dates of Requirements

All requirements of the standard for Electrical Safety-Related Work Practices have an effective date of December 4, 1990, except for 29 CFR 1910.332 (training), which will become effective on August 6, 1991.

E. Action

Regional Administrators and Area Directors shall ensure that the policies and interpretive guidelines in this instruction are followed as to the enforcement of the standard.

F. Federal Program Change

This instruction describes a Federal program change which affects State programs. Each Regional Administrator shall:

1. Ensure that this change is promptly forwarded to each State designee using a format consistent with the Plan Change Two-Way Memorandum in Appendix P, OSHA Instruction STP 2.22A, Ch-3.

2. Explain the technical content of this change to the State designee as required.

3. Ensure that State designees are asked to acknowledge receipt of this Federal program change in writing to the Regional Administrator as soon as the State's intention is known, but not later than 70 calendar days after the date of issuance (10 days for mailing and 60 days for response). This acknowledgment must include a description either of the State's plan to follow the guidelines in paragraphs H., Inspection guidelines, I., Interpretive Guidance, and J., Enforcement/Citation Guidance, to implement the change, or of the reasons why this change should not apply to that State.

4. Review policies, instructions and guidelines issued by the State to determine that this change has been communicated to State compliance personnel.

G. Background

The standard for Electrical Safety-Related Work Practices was promulgated on August 6, 1990, at Federal Register, Vol. 55, No. 151 (pages 31984-32020), and became effective December 4, 1990, except for 29 CFR 1910 .332, which becomes effective on August 6, 1991.

1. The current electrical standards in Subpart S of the General Industry Standards cover electrical equipment and installations rather than work practices. The electrical safety-related work practice standards that do exist are distributed in other subparts of 29 CFR 1910. Although unsafe work practices appear to be involved in most workplace electrocutions, OSHA has very few regulations addressing work practices necessary for electrical safety. Because of this, OSHA determined that standards were needed to minimize these hazards.

2. The new rule addresses practices and procedures that are necessary to protect employees working on or near exposed energized and deenergized parts of electric OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs equipment. The new rule also promotes uniformity and reduces redundancy among the general industry standards. The new rule is based largely on NFPA 70E, Part II.

3. On September 1, 1989, OSHA promulgated a generic standard on the control of hazardous energy, 29 CFR 1910.147 (lockout/tagout).

- That standard addresses practices and procedures that are necessary to deenergize machinery or equipment and to prevent the release of potentially hazardous energy while maintenance and servicing activities are being performed.
- b. Although that rule is related to electrical energy, it specifically excludes "exposure to electrical hazards from work on, near, or with conductors or equipment in electric utilization installations, which is covered by Subpart S of 29 CFR 1910." Therefore, the lockout/tagout standard does not cover electrical hazards.
- c. The final electrical safety-related work practices standard has provisions to achieve maximum safety by deenergizing energized parts and, secondly, when lockout/tagout is used, it is done to ensure that the deenergized state is maintained.

H. Inspection Guidelines

In so far as possible the compliance officer shall integrate inspection procedures for this standard with those of 29 CFR 1910.147 (lockout/tagout standard).

1. The following guidance provides a general framework to assist the compliance officer during all inspections: The employer's written procedures required under 29 CFR 1910.333(b)(2)(i) shall be reviewed to determine if they cover the hazards likely to be encountered. (1) A copy of paragraph (b) of 1910.333 maintained by the employer will fulfill this requirement. (2) A copy of the written procedures for locking and tagging required by 29 CFR 1910.147 will also comply with this requirement, provided those procedures address the electrical safety hazards covered by Subpart S and provided the procedures conform to 1910.333 (b). (3) If the employer has chosen to utilize procedures developed to comply with 1910.147 for electrical as well as other hazards, the written procedures must include steps corresponding to requirements in Section

1910.333 for application of locks and tags and verification of deenergized conditions (29 CFR 1910.333(b)(2)(iii)(D) and (b)(2)(iv)(B)).

Beginning August 6, 1991, the training practices of the employer for qualified and unqualified employees shall be evaluated to assess whether the training provided is appropriate to the tasks being performed or to be performed.

(1) **All employees who face a risk of electric shock, burns or other related injuries, not reduced to a safe level by the installation safety requirements of Subpart S, must be trained in safety-related work practices required by 29 CFR 1910.331-.335.**

(2) In addition to being trained in and familiar with safety related work practices, unqualified employees must be trained in the inherent hazards of electricity, such as high voltages, electric current, arcing, grounding, and lack of guarding. Any electrically related safety practices not specifically addressed by Sections 1910.331 through 1910.335 but necessary for safety in specific workplace conditions shall be included.

(3) The **training of qualified employees must include at the minimum** the following:

- The ability to distinguish exposed live parts from other parts of electric equipment.
- The ability to determine the nominal voltage of live parts.
- The knowledge of clearance and/or approach distances specified in 1910.333(c).

(4) During walkaround inspections, compliance officers shall evaluate any electrical- related work being performed to ascertain conformance with the employer's written procedures as required by 1910.333(b)(2)(i) and all safety-related work practices in Sections 1910.333 through 1910.335. (See J. of this instruction for clarification.)

(5) Any violations found must be documented adequately, including the actual voltage level.

I. Interpretive Guidance

The following guidance is provided relative to specific provisions of the standard for Electrical Safety-Related Work Practices:

A. Definitions: Qualified/Unqualified Persons. -- The standard defines a qualified person as one familiar with the construction and operation of the equipment and the hazards involved. "Qualified Persons" are intended to be only those who are well acquainted with and thoroughly conversant in the electric equipment and electrical hazards involved with the work being performed.

(1) Whether an employee is considered to be a "qualified person" will depend on various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered "qualified" with regard to certain equipment in the workplace, but "unqualified" as to other equipment. (See 29 CFR 1910.332(b)(3) for training requirements that specifically apply to qualified persons.) Only qualified persons may place and remove locks and tags.

(2) An employee who is undergoing on-the-job training, who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under

the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

(3) Where the term "may not" is used in these standards, the term bears the same meaning as "shall not".

(4) Training requirements apply to all employees in occupations that carry a risk of injury due to electrical hazards that are not sufficiently controlled under 29 CFR 1910.303 through 1910.308.

Scope/Coverage of the Standard.

- The provisions of the standard cover all employees working on, near or with premises wiring, wiring for connection to supply, other wiring, such as outside conductors on the premises and optical fiber cable, where the fiber cable installations are made along with electric conductors and the optical fiber cable types are those that contain noncurrent-carrying conductive members such as metallic strength members and metallic vapor barriers.
- b. The standard does not cover qualified workers (but does cover unqualified workers) performing work on the following:
- Electric power generation, transmission, and distribution installations located in buildings used for such purposes or located outdoors.

c. The standard for Electrical Safety-Related Work Practices was developed to complement the existing electrical standards. The new standard includes requirements for work performed on or near exposed energized and deenergized parts of electric equipment, use of electrical protective equipment, and the safe use of electrical equipment.

d. Exposure to unexpected electrical energy release that could result in electric shock or burns ***or in an explosion caused by an electric arc is covered by the standard for Electrical Safety-Related Work Practices.*** Safeguarding workers from other hazards related to the unexpected release of hazardous energy during servicing and maintenance operations is covered by 29 CFR 1910.147, the lockout/tagout standard.

(1) 1910.333(a)(1) requires that live parts be deenergized before a potentially exposed employee works on or near them. OSHA believes that this is the preferred method for protecting employees from electrical hazards. The employer is permitted to allow employees to work on or near exposed live parts only:

- If the employer can demonstrate that deenergizing introduces additional or increased hazards, or
- (b) If the employer can demonstrate that deenergizing is infeasible due to equipment design or operational limitations.

(2) Under 1910.333(a)(2) if the employer does not deenergize (under the conditions permitted in 1910.333(a)(1)), then suitable safe work practices for the conditions under which the work is to be performed shall be included in the written procedures and strictly enforced. These work practices are given in 1910.333(c) and 1910.335.

(3) Only qualified persons shall be allowed to work on energized parts or equipment.

a. Circuit parts that cannot be deenergized using the procedures outlined in 1910.333(b)(2) must be treated as energized (as specified in 1910.333 (b)(1)), regardless of whether the parts are, in fact, deenergized. Deenergized parts are required to be locked and tagged unless exempted under 1910.333(b)(2) (iii)(C) or 1910.333(b)(2)(iii)(E), as discussed below. If so exempted, either a lock or a tag is required.

b. If a tag is used without a lock, it shall be supplemented by at least one additional safety measure that provides a level of safety equivalent to that obtained by the use of a lock. Examples of additional safety measures include the removal of an isolating circuit element, blocking of a controlling switch, or opening of an extra disconnecting device.

c. *A lock may be placed without a tag only* under the following conditions:

- Only one circuit or piece of equipment is deenergized, and
- (b) The lockout period does not extend beyond the work shift, and
- (c) Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure.

4. Verification of Deenergization Is Mandatory. This verification must be done by a qualified person.

- The qualified person shall activate the equipment operating controls or otherwise verify that the equipment cannot be restarted.
- b. Test equipment shall be used to ensure that electrical parts and circuit elements have been deenergized.
- c. Testing instruments and equipment shall be visually inspected for external defects or damage before being used to determine deenergization (29 CFR 1910.334(c)(2)).
- d. For circuits over 600 volts nominal, the test equipment shall be checked for proper operation immediately before and immediately after the test.

5. Reenergization. The following requirements shall be met, in the order given, before circuits or equipment are reenergized, even temporarily.

a. A qualified person shall conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed so that the circuits and equipment can be safely energized.

b. Potentially exposed employees shall be warned to stay clear of circuits and equipment prior to reenergizing.

c. Each lock and tag shall be removed by the employee who applied it. However, if the employee is absent from the workplace, then the lock or tag may be removed by a qualified person designated to perform this task provided that the employer ensures:

- That the employee who applied the lock or tag is not available at the workplace, and
- That the employee is informed that the lock or tag has been removed before he or she resumes work at the workplace.
- That there is to be a visual determination that all employees are clear of the circuits and equipment prior to lock and tag removal.

6. Working On or Near Overhead Power Lines, 29 CFR 1910.333(c)(3).

a. OSHA believes that the preferred method of protecting employees working near overhead power lines is to deenergize and ground the lines when work is to be performed near them.
b. In addition to other operations, this standard also applies to tree trimming operations performed by tree workers who are not "qualified persons". In this respect the exclusion in 1910.331(c)(1) applies only to "qualified persons" performing line-clearance tree trimming (trimming trees that are closer than 10 feet to overhead power lines).

c. The standard does not prohibit workers who are not "qualified persons" from working in a tree that is closer than 10 feet to power lines so long as that person or any object he or she may be using, does not come within 10 feet of a power line. However, it would require "qualified persons" to perform the work if the worker or any object he or she may be using will come within 10 feet of an exposed energized part or if a branch being cut may be expected to come within 10 feet of an exposed energized part while falling from the tree. (See 29 CFR 1910.333(c)(3)(ii).)

d. The purpose for the approach distance requirements is to prevent contact with, and/or arcing, from energized overhead power lines. The approach distance applies to tools used by employees as well as the employees themselves. Table S-5 calls for the following approach distances for qualified employees only:

Voltage Range (AC) Minimum Approach
(phase to phase) Distance

- 300V and less ……………………………Avoid contact
- Over 300V, not over 750V ……………...1 ft. 0 in. (30.5cm)
- Over 750, not over 2kV …………………1 ft. 6 in. (46cm)
- Over 2kV, not over 15kV ………………..2 ft. 0 in. (61cm)
- Over 15kV, not over 37kV ………………3 ft. 0 in. (91cm)
- Over 37kV, not over 87.5kV …………….3 ft. 6 in. (107cm)
- Over 87.5kV, not over 121kV …………..4 ft. 0 in. (122cm)
- Over 121kV, not over 140kV ……………4 ft. 6 in. (137cm)

NOTE: Unqualified employees are required to adhere to the 10 ft. minimum. e. Employees working on or around vehicles and mechanical equipment, such as gin-pole trucks, forklifts, cherry pickers, garbage trucks, cranes and elevating platforms, who are potentially exposed to hazards related to equipment component contact with overhead lines, shall have been trained by their employers in the inherent hazards of electricity and means of avoiding exposure to such hazards. The standard for Electrical Safety-Related Work Practices can be applied with respect to electrical hazards related to any size, utilization or configuration of overhead power lines in general industry; e.g., residential power lines, remotely located overhead power lines, temporarily rigged overhead power lines, and overhead power lines along streets and alleys.

7. Portable Ladders. Such ladders may not have conductive siderails in situations where the employee or the ladder could contact exposed energized parts. All ladders shall be in compliance with requirements of the standards found elsewhere in Part 1910.

8. Conductive Apparel. Articles of jewelry and clothing such as watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear shall not be worn if there is a possibility of contacting exposed energized parts. However, such

articles may be worn if they are rendered nonconductive by covering, wrapping, or other insulating means (29 CFR 1910.333(c)(8)).

9. Housekeeping Duties. The employer has the burden to provide adequate safeguards (such as insulating equipment or barriers) where live parts present an electrical contact hazard to employees who are performing housekeeping duties. Electrically conductive cleaning materials (such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

10. Electrical Safety Interlocks. Interlocks found on panels, covers and guards are designed to deenergize circuits to prevent electric shock to persons using equipment or performing minor maintenance or adjustments and **shall not be defeated or bypassed** by an unqualified person.

11. Cord- and Plug-Connected Equipment. Energized equipment here means either the equipment being plugged or the receptacle into which it is being plugged, or both (29 CFR 1910.334(a)(5)(i)).

12. Eye and Face Protection. 29 CFR 1910.335(a)(1)(v) requires employees to wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from **electric arcs or flashes** or from flying objects **resulting from electrical explosion.**

13. Insulated Tool. This means a tool encased within material of composition and thickness that is recognized as electrical insulation.

J. Enforcement/Citation Guidance

1. A deficiency in the employer's program that could contribute to a potential exposure capable of producing serious physical harm or death shall be cited as a serious violation.

2. The failure to train "qualified" and "unqualified" employees as required for their respective classifications shall normally be cited as a serious violation.

3. Paperwork deficiencies in the safe work practice program where effective safe work practice procedures are in place shall be cited as other-than-serious. [Gerard F. Scannell, Assistant Secretary]

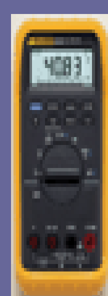
Excerpt from OSHA Standard (Note this can ***only*** be performed by "Qualified" persons):

1910.334(b)(2)

"Reclosing circuits after protective device operation." After a circuit is deenergized by a circuit protective device, the circuit protective device, **the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses is prohibited.**

Note: When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is reenergized.

Use the Appropriate PPE & Tools



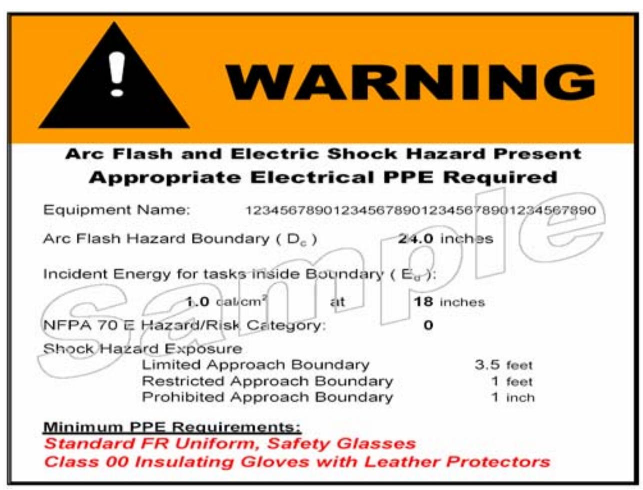
Arc Flash Assessment

Needs:

- **Single Line Electrical Diagram** for facility
- **Fuses:** Manufacturer, type, amp rating, short circuit rating, time delay
- **Circuit Breakers:** Manufacturer, type, amp rating, short circuit rating, time delay
- **Panel & Switchboards:** Manufacturer, type, amp rating, short circuit rating, time delay (include all internal fuses and circuit breakers)
- **Primary Transformers:** size, impedance, fusing, short circuit available, time delay (can be obtained from power company)
- **Secondary Transformers:** size, impedance, fusing, short circuit available, time delay
- **Disconnects:** size, short circuit ratings, fusing, time delay
- **Bus Ducts:** size, short circuit rating and all buckets or disconnects on the duct, fusing, length
- **Equipment Panels:** All exposures that are on the end of the line fed from the above panels/switchboards. Short circuit ratings, fusing/circuit breakers, time delay in the panel.
- **Primary Electrical Equipment (facility owned):** wiring, fusing, switchgear.

Then:

1. Perform a system Short Circuit Analysis and Overcurrent Protection Coordination
2. Interrupt Rating Analysis
3. Calculate Arc Flash Incident Energy at each point in system
4. Determine if circuit breaker or fusing changes can reduce the incident energy (which could reduce the boundaries and lessen the PPE requirements)
5. Calculate Arc Flash Boundaries for each point in system
6. Determine Personal Protective Equipment (PPE) for Arc Flash Incident Energy determined (#3 above)
7. Label all points in the system with appropriate labels.
8. Provide “Qualified” personnel that has the responsibility to work inside the Arc Flash Boundary with Electrical/Arc Flash training and information needed to work safely.
9. Provide Basic Electrical Awareness training for everyone at the facility.



Site Name / Location : Westmoreland FG&E

Case Number: 150

Injury Type/Body Part : Burns – Both Legs

Date: 10/27/07

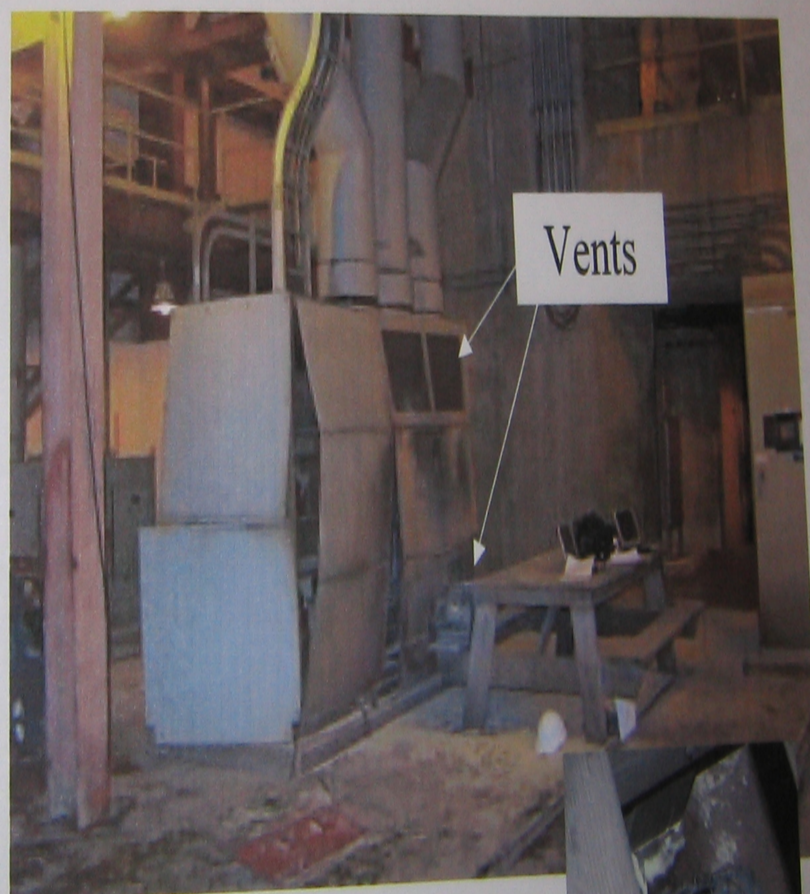
Recordability Rationale: Immediate Hospitalization for 2nd degree burns

Lost Workdays: YES

Restricted Duty: YES

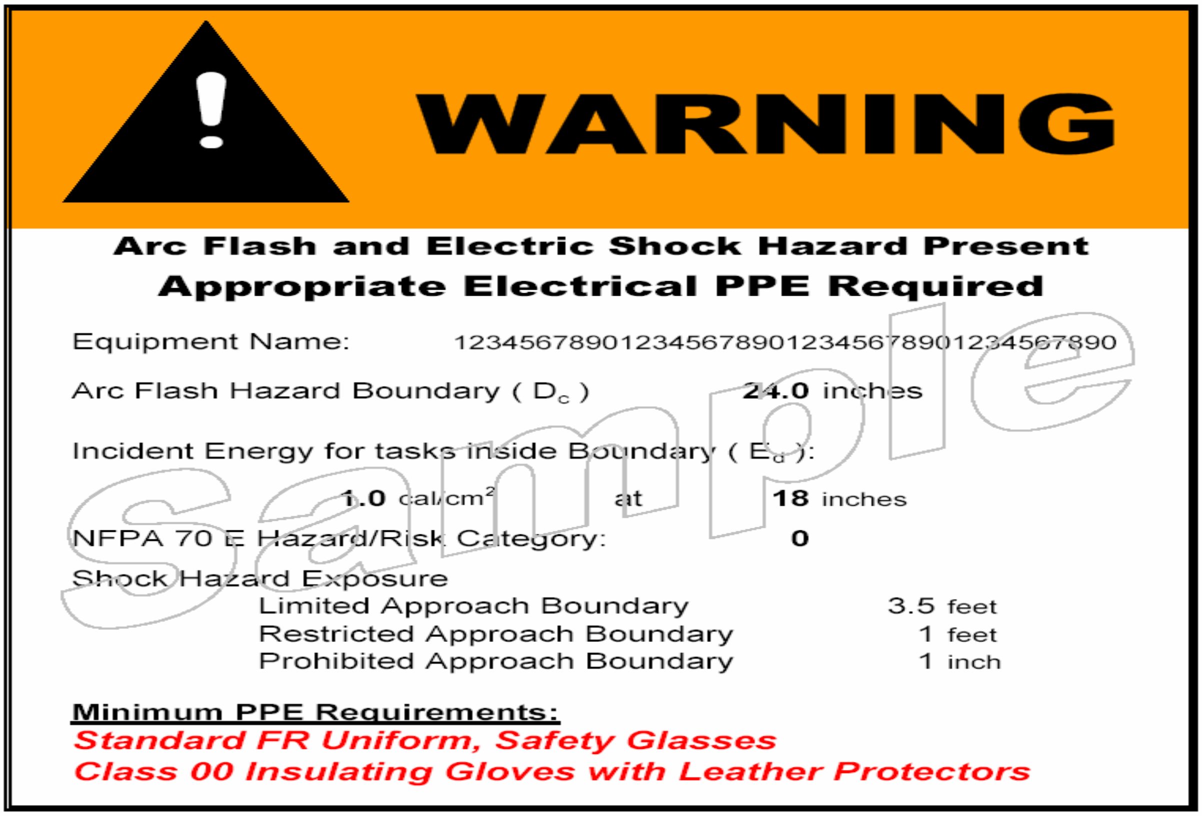
Management system failure: Process Hazard Analysis – Preliminary failure cause

Description: Employee was sitting in from of a PPT (Primary Power Transformer) reviewing control module EX2100 catalog during a generator start up test during a planned outage, the PPT/PT faulted (unknown) and an arc flash blast plasma ball was released which caused burns to the GSI employee (15KV)



Root Causes : Definitive RCA is still under investigation.

Contributing causes are related to no known arc flash blast boundary calculations conducted by the customer, temporary work bench (picnic table) placement, inappropriate PPE (synthetic safety shoes), unawareness of immediate safety devices (emergency shower), undefined generator start-up procedures.



- **<u>Shock Hazard Exposure</u>** – These approach boundaries are referring to the electrical shock hazard and ***NOT*** the arc flash hazard. ***<u>WARNING:</u>*** The arc flash boundary may be greater or less than the shock boundary.
- **<u>Limited Approach Boundary</u> –** entered by "Qualified" persons or unqualified persons escorted by qualified person.
- **<u>Restricted Approach Boundary</u> –** entered only by qualified persons required to use shock protection techniques and equipment.
- **<u>Prohibited Approach Boundary</u> –** entered only by qualified persons requiring same protection as if in direct contact with live part.

- **<u>NOTE:</u>** Each boundary is a sphere to be observed in all directions (Three dimensional / 360 degrees)

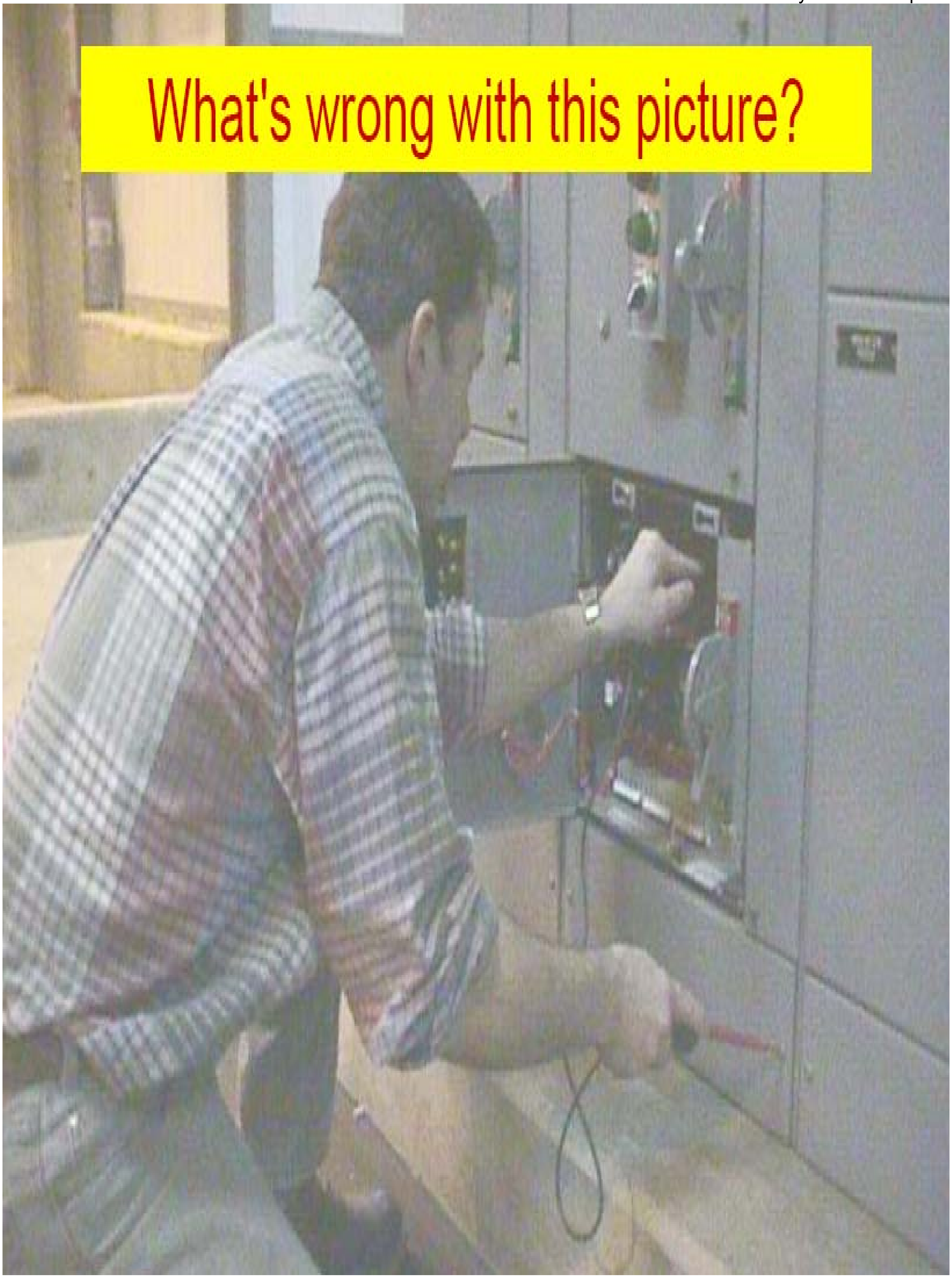
Figure 9: Shock Hazard Safe Approach Boundaries

A **Qualified Person** is:

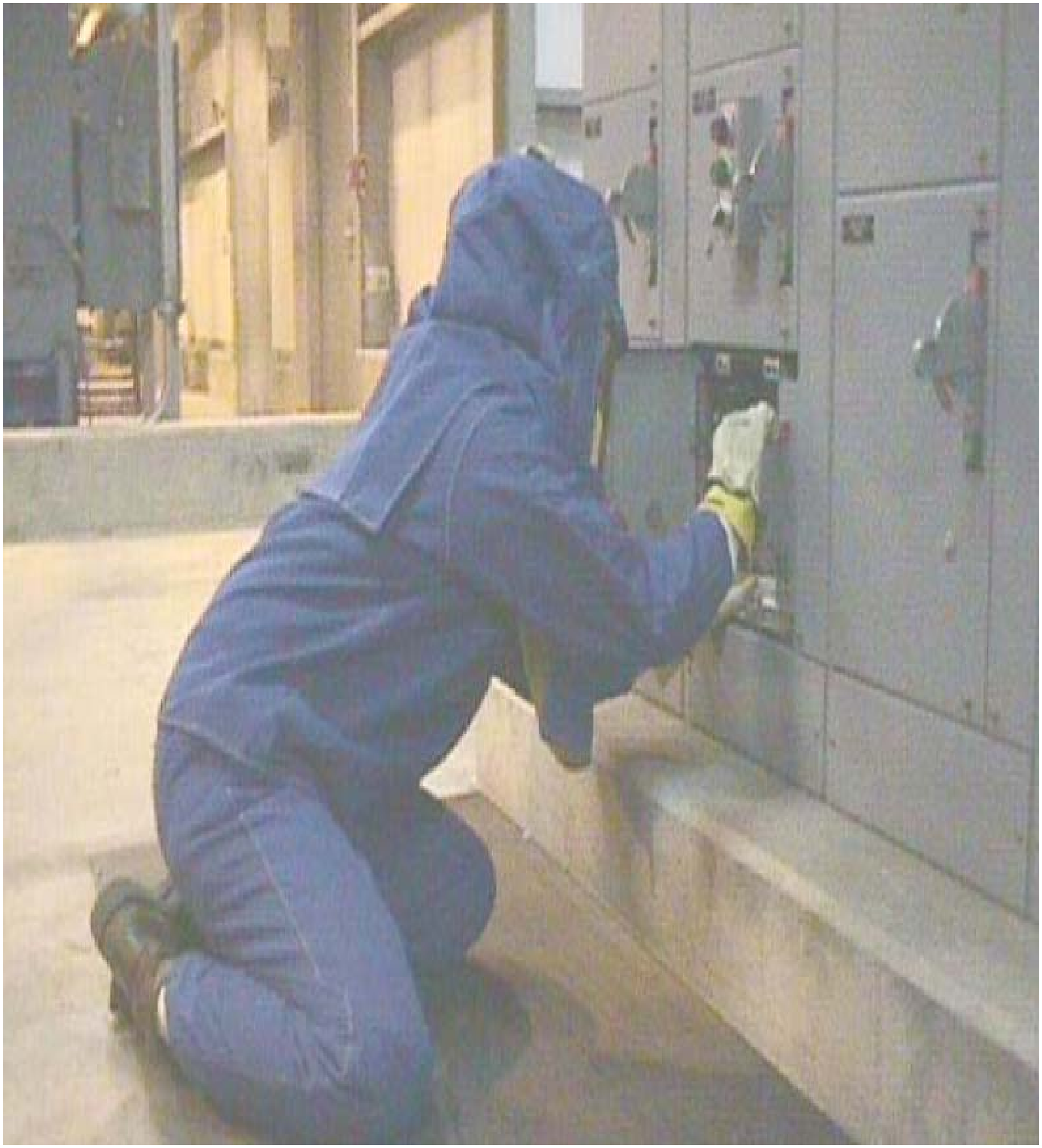
1. Trained and knowledgeable in the construction and operation of equipment or specific work method.
2. Able to recognize and avoid electrical hazards
3. May be qualified with respect to certain equipment and methods but unqualified for others.

For a **"Qualified Person"** to work within the Limited Approach Boundary they must be trained to:

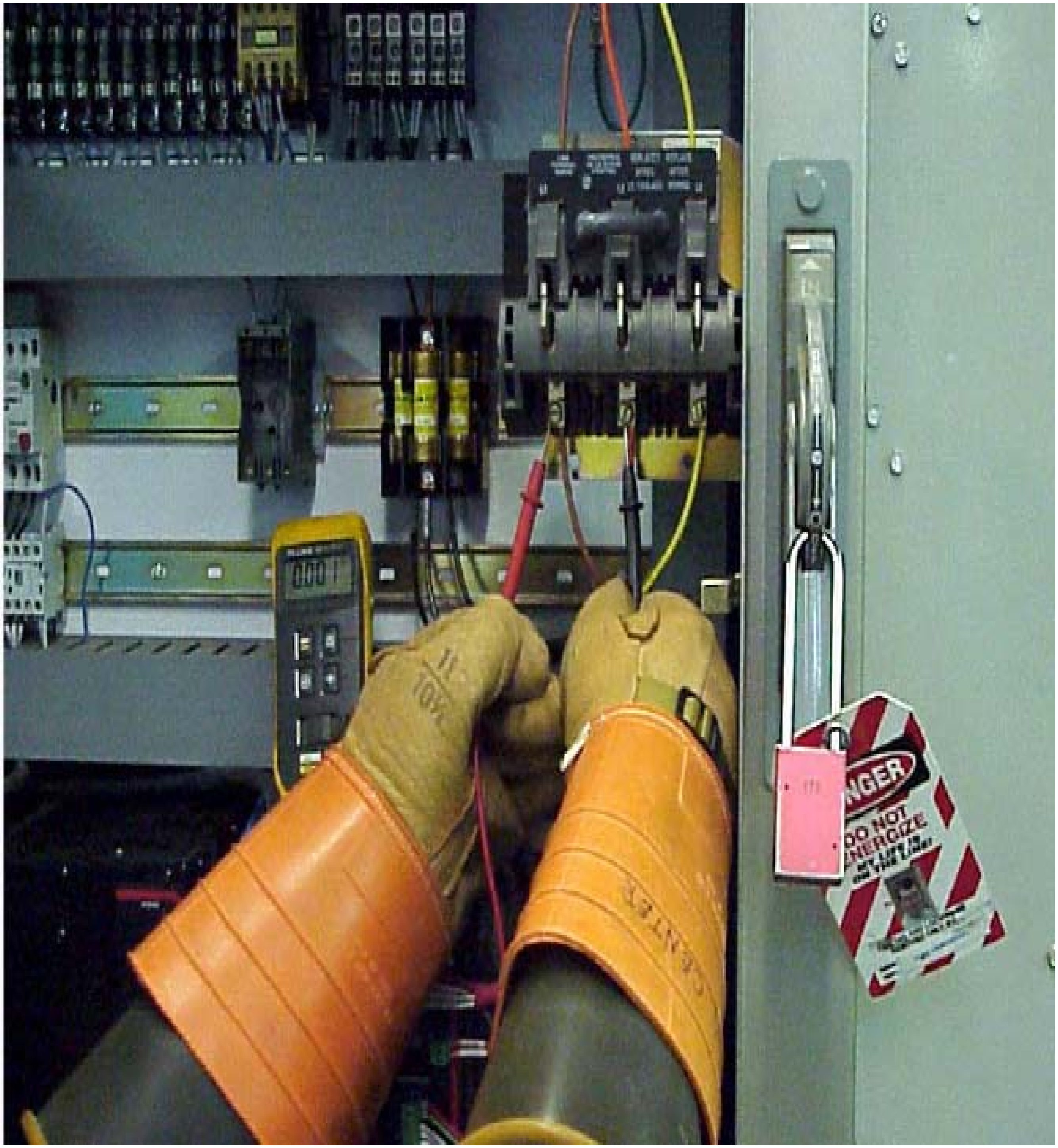
1. Distinguish exposed energized parts from others
2. Determine nominal voltage
3. Determine approach distances
4. Determine degree and extent of hazard and PPE required


What's wrong with this picture?

Correct way to verify!



Is there any potential for live energy anywhere in this cabinet?

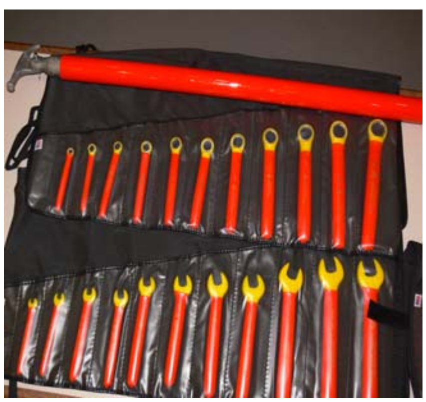


Which ones of these are electrically rated?

Yes _____ No ______

Yes ______ No _____

Yes ______ No ______



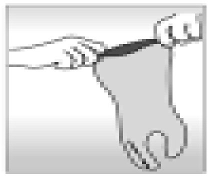
Yes _____ No _____

Yes _____ No _____

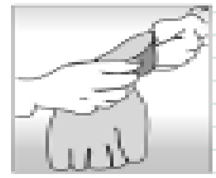
Inspection of Insulating Equipment Before Use

Inspect insulating equipment for damage before each use and immediately following any incident. Insulating gloves shall be given an air test, along with the inspection.

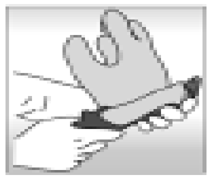
1. Hold the Glove with thumbs and fore fingers as illustrated.



2. Twirl the glove around quickly to fill with air.



3. Trap the air by squeezing the gauntlet with one hand. Use the other hand to squeeze the palm, fingers and thumb in looking for weaknesses and defects.



4. Hold the glove to the face to detect air leakage or hold it to the ear and listen for escaping air.

(16) Care and Maintenance of FR Clothing and FR Flash Suits.

(a) Inspection. FR apparel shall be inspected before each use. Work clothing or flash suits that are contaminated, or damaged to the extent their protective qualities are impaired, shall not be used. Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.

(b) Manufacturer's Instructions. The garment manufacturer's instructions for care and maintenance of FR apparel shall be followed.

1910.137 Electrical Protective Devices (Excerpt)

Table I-6. - Rubber Insulating Equipment Test Intervals

Type of equipment	When to test
Rubber insulating line hose	Upon indication that insulating value is suspect.
Rubber insulating covers	Upon indication that insulating value is suspect.
Rubber insulating blankets	Before first issue and every 12 months thereafter(1).
Rubber insulating gloves	Before first issue and every 6 months thereafter(1).
Rubber insulating sleeves	Before first issue and every 12 months thereafter(1).

Footnote(1) If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.

The Hierarchy of Health & Safety Controls

Research indicates that fixing the workplace approach is actually more effective and less expensive in the long run. One reason is that human behavior can never be completely regulated and controlled, so solutions based on compliance with procedures will always lead to mishaps. Control of Hazardous Energy (LOTO) is much more capable of guaranteeing safety and health. The UAW's and OSHA's analysis of control effectiveness is captured in the graph below.

MOST EFFECTIVE	1. Elimination or Substitution	• substitute with less hazardous material • change process to eliminate noise • perform task at ground level • automated material handling
↓	2. Engineering Controls	• ventilation systems • machine guarding • **Electrical enclosures** • **Current limiting circuit breakers/fuses** • interlocks • lift tables, conveyors, balancers
↓	3. Warnings	• odor in natural gas • **signs** • **Barricades** • horns • **labels**
↓	4. Training & Procedures	• **Safe job procedures** • Safety equipment inspections • Hazard Communications Training • Lock-out • Confined Space Entry, etc…
LEAST EFFECTIVE	5. Personal Protective Equipment	• **safety glasses** • ear plugs • **Flame Retardant Clothing** • **face shields** • safety harnesses and lanyards • **Gloves**

Does your group agree about where to focus in the hierarchy? NO____ YES____

What Are Your Goals & Concerns?

I. What goals do you want to achieve?

1. ____________________

____

____

2. ____________________

____

____

3. ____________________

____

____

4. ____________________

____

____

5. ____________________

____

____

6. ____________________

____

Exploring Common Ground

1st: In the small groups, **prioritize the goals you have identified** in order of importance, ranking them by the total number of goals each group listed. .

2nd: Each group **reports out its goals**, one at a time, **without identifying their priority ranking**.

3rd: The entire group discusses the following questions:

1. How much **common ground** do groups have **in their goals**?
2. What **surprised you in the other group's list** that you now realize is important?
3. Do the **common goals appear to be a full agenda?**
4. What **goals** are **different?** *Why are they important to the group that presented them?*

4th: Each small group will report out **how it has prioritized goals.**

5th: The large group discusses the following questions:

5. What **similarities and differences are there in the group's priorities?**
6. **What difficulties might these differences cause?**

   1) ______________________________
   2) ______________________________
   3) ______________________________
   4) ______________________________

6th: Each group **reports out its concerns,** one at a time, using a round robin as above.

7th: Engage the full group in discussing the following questions.

7. What **common concerns** does the group have?

Building an Agenda

Common Ground – Goals for Worksite	Priority
1. ______________________________	# __
2. ______________________________	# __
3. ______________________________	# __
4. ______________________________	# __
5. ______________________________	# __
6. ______________________________	# __
7. ______________________________	# __
8. ______________________________	# __
Note: Items on page 41 will need to be incorporated in your goals if not completed.	

Identify and Investigate Electrical Hazards

- **Conduct electrical inspections and walk-arounds**.

Has this been done? o YES If so, by whom? ______________________________ o NO
If not, to whom will this be assigned? ____

- **Gather information from workers** in meetings, through surveys, suggestion programs, task forces on potential electrical hazards.

Has this been done? o YES If so, by whom? _______________________________ o NO
If not, to whom will this be assigned? ____

- Investigate **equipment electrical** hazards.

Has this been done? o YES If so, by whom? _______________________________ o NO
If not, to whom will this be assigned? ____

- **Audit electrical operating procedures** to identify hazards or concerns in work processes.

Has this been done? o YES If so, by whom?________________________________ o NO
*If not, to whom will this be assigned?*____

- **Provide Education and Training**
  a. For **Skilled Trades**
  b. For **Supervision**
  c. For **Workforce**

Preparing for an Inspection

Prior to the inspection, review OSHA Sub Part "S" and NFPA 70E requirements and suggestions, what complaints, near misses and problems that have been reported or are apparent from records, such as:

- Workers' questions, concerns, suggestions
- OSHA 300 Logs and 301 reports
- Near miss reports
- First aid/accident logs
- Previous Year's Lock-Out Plan
- Electrical Safe Work Practices for facility

Plan for the inspection by pursuing the following questions:

1) **What are people doing in the area to be inspected?** Review these:
   a) Site map and building plans
   b) Process flow charts
   c) Single line electrical drawings
   d) Narrative description of operations
   e) Written operating procedures

2) **What previous assessments were made?** Don't duplicate work!! Review:
   a) Reports of previous inspections

3) **What is the right way to do an electrical assessment?** Don't reinvent the wheel! Review:
   a) OSHA (available on-line), NFPA, NEC, ANSI, ASHRAE standards (available for purchase)
   b) Electrical contractors reports, if they provide services to your worksite
   c) Others references

3. Small Group Analysis of Inspection Checklists

1) **What would you want to** make sure you **include** in an Electrical checklist for your worksite?

____

____

____

____

____

____

____

____

2) **What would you want to avoid** in creating a checklist for your site?

3) **What topics are important to your site that aren't addressed – or are under-addressed -- by these checklists?** What would your checklist include for these topics?

Electrical Compliance Checklist

(OSHA Small Business Publication #2209-02R 2005)

1. Do you require compliance with OSHA standards for all contract electrical work? **Yes** / **No** / **Don't Know** or **Incomplete**
2. Are all employees required to report any obvious hazard to life or property in connection with electrical equipment or lines as soon as possible? **Yes** / **No** / **Don't Know** or **Incomplete**
3. Are employees instructed to make preliminary inspections and/or appropriate tests to determine conditions before starting work on electrical equipment or lines? **Yes** / **No** / **Don't Know** or **Incomplete**
4. When electrical equipment or lines are to be serviced, maintained, or adjusted, are necessary switches opened, locked out or tagged, whenever possible? **Yes** / **No** / **Don't Know** or **Incomplete**
5. Are portable electrical tools and equipment grounded or of the double insulated type? **Yes** / **No** / **Don't Know** or **Incomplete**
6. Are electrical appliances such as vacuum cleaners, polishers, vending machines, etc., grounded? **Yes** / **No** / **Don't Know** or **Incomplete**
7. Do extension cords have a grounding conductor? **Yes** / **No** / **Don't Know** or **Incomplete**
8. Are multiple plug adaptors prohibited? **Yes** / **No** / **Don't Know** or **Incomplete**
9. Are ground-fault circuit interrupters installed on each temporary 15 or 20 ampere, 120 volt alternating current (AC) circuit at locations where construction, demolition, modifications, alterations, or excavations are being performed? **Yes** / **No** / **Don't Know** or **Incomplete**
10. Are all temporary circuits protected by suitable disconnecting switches or plug connectors at the junction with permanent wiring? **Yes** / **No** / **Don't Know** or **Incomplete**
11. Do you have electrical installations in hazardous dust or vapor areas? If so, do they meet the National Electrical Code (NEC) for hazardous locations? **Yes** / **No** / **Don't Know** or **Incomplete**
12. Are exposed wiring and cords with frayed or deteriorated insulation repaired or replaced promptly? **Yes** / **No** / **Don't Know** or **Incomplete**
13. Are flexible cords and cables free of splices or taps? **Yes** / **No** / **Don't Know** or **Incomplete**
14. Are clamps or other securing means provided on flexible cords or cables at plugs, receptacles, tools, equipment, etc., and is the cord jacket securely held in place? **Yes** / **No** / **Don't Know** or **Incomplete**
15. Are all cord, cable and raceway connections intact and secure? **Yes** / **No** / **Don't Know** or **Incomplete**
16. In wet or damp locations, are electrical tools and equipment appropriate for the use or location or otherwise protected? **Yes** / **No** / **Don't Know** or **Incomplete**

17. Is the location of electrical power lines and cables (overhead, underground, under floor, other side of walls, etc.) determined before digging, drilling, or similar work is begun? **Yes** / **No** / **Don't Know** or **Incomplete**

18. Are metal measuring tapes, ropes, hand-lines or similar devices with metallic thread woven into the fabric prohibited where they could come in contact with energized parts of equipment or circuit conductors? **Yes** / **No** / **Don't Know** or **Incomplete**

19. Is the use of metal ladders prohibited where the ladder or the person using the ladder could come in contact with energized parts of equipment, fixtures, or circuit conductors? **Yes** / **No** / **Don't Know** or **Incomplete**

20. Are all disconnecting switches and circuit breakers labeled to indicate their use or equipment served? **Yes** / **No** / **Don't Know** or **Incomplete**

21. Are disconnecting means always opened before fuses are replaced? **Yes** / **No** / **Don't Know** or **Incomplete**

22. Do all interior wiring systems include provisions for grounding metal parts of electrical raceways, equipment and enclosures? **Yes** / **No** / **Don't Know** or **Incomplete**

23. Are all electrical raceways and enclosures securely fastened in place? **Yes** / **No** / **Don't Know** or **Incomplete**

24. Are all energized parts of electrical circuits and equipment guarded against accidental contact by approved cabinets or enclosures? **Yes** / **No** / **Don't Know** or **Incomplete**

25. Is sufficient access and working space provided and maintained around all electrical equipment to permit ready and safe operations and maintenance? **Yes** / **No** / **Don't Know** or **Incomplete**

26. Are all unused openings (including conduit knockouts) in electrical enclosures and fittings closed with appropriate covers, plugs, or plates? **Yes** / **No** / **Don't Know** or **Incomplete**

27. Are electrical enclosures such as switches, receptacles, junction boxes, etc., provided with tight-fitting covers or plates? **Yes** / **No** / **Don't Know** or **Incomplete**

28. Are disconnecting switches for electrical motors in excess of two horsepower able to open the circuit when the motor is stalled without exploding? (Switches must be horsepower rated equal to or in excess of the motor rating.) **Yes** / **No** / **Don't Know** or **Incomplete**

29. Is low voltage protection provided in the control device of motors driving machines or equipment that could cause injury from inadvertent starting? **Yes** / **No** / **Don't Know** or **Incomplete**

30. Is each motor disconnecting switch or circuit breaker located within sight of the motor control device? **Yes** / **No** / **Don't Know** or **Incomplete**

31. Is each motor located within sight of its controller or is the controller disconnecting means able to be locked open or is a separate disconnecting means installed in the circuit within sight of the motor? **Yes** / **No** / **Don't Know** or **Incomplete**

32. Is the controller for each motor that exceeds two horsepower **Yes** / **No** / **Don't Know**

rated equal to or above the rating of the motor it serves? or **Incomplete**

33. Are employees who regularly work on or around energized electrical equipment or lines instructed in cardiopulmonary resuscitation (CPR)? **Yes** / **No** / **Don't Know** or **Incomplete**

34. Are employees prohibited from working alone on energized lines or equipment over 600 volts? **Yes** / **No** / **Don't Know** or **Incomplete**

LOCKOUT/TAGOUT PROCEDURES Checklist

- ☐ Is all machinery or equipment capable of movement required to be de-energized or disengaged and blocked or locked out during cleaning, servicing, adjusting, or setting up operations?
- ☐ If the power disconnect for equipment does not also disconnect the electrical control circuit, are the appropriate electrical enclosures identified and is a means provided to ensure that the control circuit can also be disconnected and locked out?
- ☐ Is the locking out of control circuits instead of locking out main power disconnects prohibited?
- ☐ Are all equipment control valve handles provided with a means for locking out?
- ☐ Does the lockout procedure require that stored energy (mechanical, hydraulic, air, etc.) be released or blocked before equipment is locked out for repairs?
- ☐ Are appropriate employees provided with individually keyed personal safety locks?
- ☐ Are employees required to keep personal control of their key(s) while they have safety locks in use?
- ☐ Is it required that only the employee exposed to the hazard can place or remove the safety lock?
- ☐ Is it required that employees check the safety of the lockout by attempting a startup after making sure no one is exposed?
- ☐ Are employees instructed to always push the control circuit stop button prior to re-energizing the main power switch?
- ☐ Is there a means provided to identify any or all employees who are working on locked-out equipment by their locks or accompanying tags?
- ☐ Are a sufficient number of accident prevention signs or tags and safety padlocks provided for any reasonably foreseeable repair emergency?
- ☐ When machine operations, configuration, or size require an operator to leave the control station and part of the machine could move if accidentally activated, is the part required to be separately locked out or blocked?
- ☐ If equipment or lines cannot be shut down, locked out and tagged, is a safe job procedure established and rigidly followed?

Making sure your worksite has SMART Goals

Your worksite may need to establish SMART Goals that allow you to carry out your ideas. These will be based on the actions that you have written on your Post-It Notes.

Your action steps or goals must be:

Specific **M**easurable **A**ssigned **R**ealistic **T**imed

- ✓ Is it **Specific?**
- ✓ Is it **Measurable?**
- ✓ Is it **Assigned?**
- ✓ Is it **Realistic?**
- ✓ Does it have a **Timeline?**

- Using the list of characteristics above, **add details to make to your Post-It Notes to make the action items SMART**.
  - Is it **specific** enough? (i.e. "Label all disconnects" is usually not specific enough! Locate them where on the panel / disconnect? What information do you want on the label?)
  - Is it **measurable**?
  - **Who's responsible** for the follow through? ("Which individual is assigned to ensure that the task gets done? Who will help him or her in what specific ways?)
  - **How long** will it take to get done from the time it starts? Once you've plotted a start date on your schedule, set a deadline for having it done!
- You may find that one Post-It note action has become three of four! Use one note for each separate assignment needed to accomplish the goal.

Once you've finished developing your list of SMART goals or action items, **plot them out on the flipchart grid** and check them again to see how realistic a plan your plan is.

Developing a Plan

Month # 1	**Month # 2**	**Month # 3**	**Month # 4**	**Month # 5**	**Month # 6**
Month # 7	**Month # 8**	**Month # 9**	**Month # 10**	**Month # 11**	**Month # 12**

Excerpt from "American Electricians' Handbook" 7th Edition, 1953, McGraw-Hill:

"Electricians often test circuits for the presence of voltage by touching the conductors with the fingers. This method is safe where the voltage does not exceed 250V and is often very convenient for locating a blown-out fuse or for ascertaining whether or not a circuit is alive."

Calendar from 1938 with “Reddy Kilowatt" - the electric industry's mascot. Picture credit: corbis.com