



Electrical Safety Awareness for Telecom Workers Training Course

INSTRUCTOR MANUAL



605-882-5865
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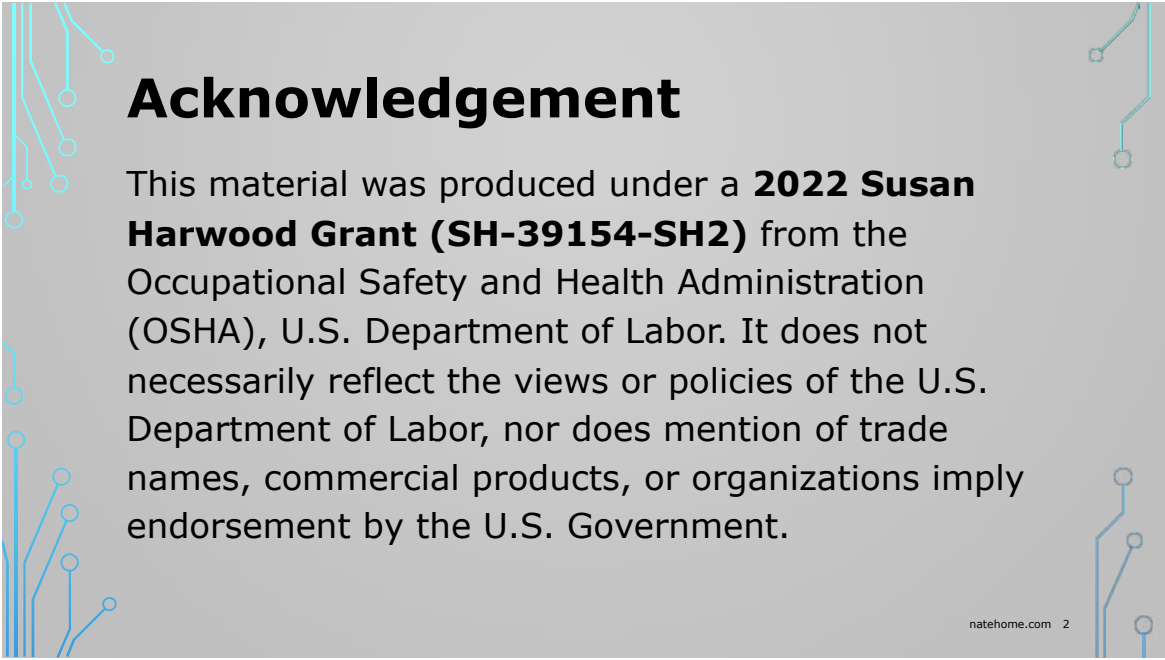
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Course Objective

In an effort to improve safety within the telecommunications industry this course was developed to cover basic electrical theory and highlight electrical equipment and associated hazards frequently encountered by technicians. The objective is to provide a solid foundation for general electrical safety, increase electrical knowledge and bring awareness to telecommunication industry workers in an effort to reduce electrical related incidents and associated hazards.

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Acknowledgement

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Acknowledge that funding for the development of this training and delivery of the training was provided by the Department of Labor through a Susan Harwood Grant.

Disclaimer

This electrical safety awareness course does not qualify you to work on or around energized circuits and equipment.

Additional training is required to become qualified to work on or around energized circuits and equipment.

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OSHA Information for Employers and Employees

SECTION 1 Introduction to NATE and OSHA



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INSTRUCTOR MANUAL

Electrical Safety Awareness for Telecom Workers Training Course

About NATE

- Global leader in industry safety and best practices for 27 years;
- Voice of tower and communications infrastructure, construction, service, and maintenance industries; and
- Diverse membership make-up consisting of over 1,050 member companies.



Talk about the vital role NATE plays in the wireless and broadcast infrastructure industries.

Share their personal connection to NATE and how they have worked with NATE through the years.

Mission Statement:

- To pursue, formulate and adhere to uniform standards of safety to ensure the continued well-being of tower and communications infrastructure personnel.
- To educate the general public, applicable government agencies, Congress and clients on policy priorities and continued progress toward safer standards and practices within the industry.
- To keep all members informed of issues relevant to the industry.
- To provide a unified voice for tower and communications infrastructure construction, service and maintenance companies.
- To facilitate effective safety training for the industry.

What Does OSHA Do?

- Works with employers and employees to reduce workplace hazards through partnerships and alliances;
- Introduces new or improves upon existing safety and health programs;
- Utilizes consensus standards through an agreement with multiple consensus standards, including API, IIAR, ASME, and ANSI
- Educates on safety and health rules that are designed to protect workers;
- Enforces the rules through inspection and citations;
- Monitors job-related injuries and illnesses through electronic records and reporting; and
- Conducts a variety of inspections to include accidents, fatalities, complaints, and programmed inspections.

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Note that OSHA (the Occupational Safety and Health Administration) is a regulatory agency of the federal government that has been established to ensure that the Law is adhered to by regulating employers. This is accomplished by developing standards consistent with the law, educating employers and employees and enforcing the standards on employers.

Employers Must

- Provide a workplace free from recognized hazards and comply with standards, rules and regulations issued under the OSH Act;
- Eliminate or reduce hazards by making feasible changes in working conditions;
- Not discriminate against employees who exercise their rights under the Act;
- Inform employees of hazards through training, labels, alarms, etc.;
- Train employees in a language/vocabulary employees can understand; and
- Keep accurate records of work-related injuries and illnesses.

Source: OSHA 3021-09R 2011, www.osha.gov/workers

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Point out the employer's responsibilities to protect their employees.

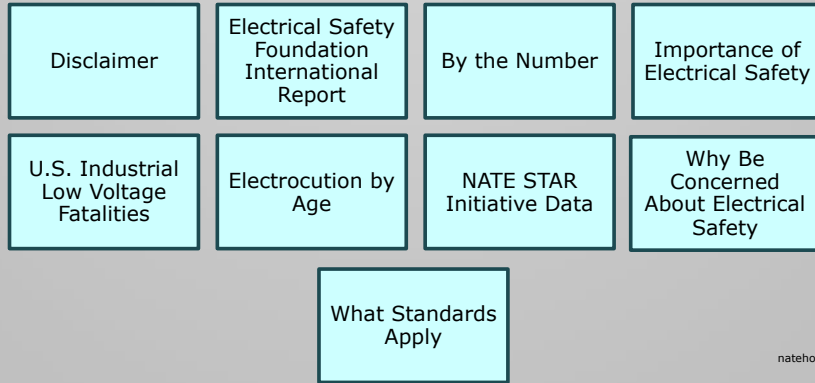
SECTION 1 KEY POINTS

1. OSHA (Occupational Safety and Health Administration).
 - a. Regulatory agency of the federal government.
 - b. Established to ensure that the law is adhered to by regulating employers.
2. Employers are responsible for protecting their employees.
3. Workers have rights.
4. OSHA whistleblower protection.
 - a. Visit [osha.gov/workers](https://www.osha.gov/workers) or call 800-321-OSHA (6742).

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SECTION 2

Industry Statistics Related to Telecom-Related Electrical Work



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By the Numbers

Annually, U.S. Averages

+1,200

Workers admitted to burn centers/hospitals for fire/flame and electrical burns*

2,000

Electrical injuries requiring days away from work

Top Occupations

31%

Installation, Maintenance, Repair

25%

Construction, Excavation

In last 10 years**

+1,800

Workplace fatalities from exposure to electricity

Every other day

1

Worker is electrocuted

* Based on NBR 2016 Report data **2005-2014, bls.gov

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Electricity presents a significant hazard in the workplace.

We are safer than we were 20 years ago, but injuries and fatalities due to electrical hazards are still devastating and all too common.

More than 1,200 people are admitted annually with either fire/flame or electrical burns from work-related accidents, according to National Burn Repository data.

Over the last five years, electrical exposure injuries with missed days have averaged around 2,000. Within this the top two occupation groups, "installation, maintenance and repair" occupations have a 31% share, while construction accounts for another 25% of the injuries.

[CLICK]

From 2005 through 2014, the latest year available, there have been more than 1,800 fatalities due to electrical accidents.

Another way to put it...

An electrical related incident at work ...cost someone their life yesterday and tomorrow it will be another life, and every other day after that.

NOTES: Data sources Bureau of Labor Statistics www.bls.gov

ALL Within "Exposure to Electricity" EVENT

1,864 Total Fatalities 2005-2014

Injuries 2010-2014: 5-year TOTALS

3,050

OCCUPATION GROUP

Installation, maintenance, and repair

Construction and extraction

Service

Production

OTHER

5-year Average ALL: 1,964/yr

2,470

1,550

1,070

1,550

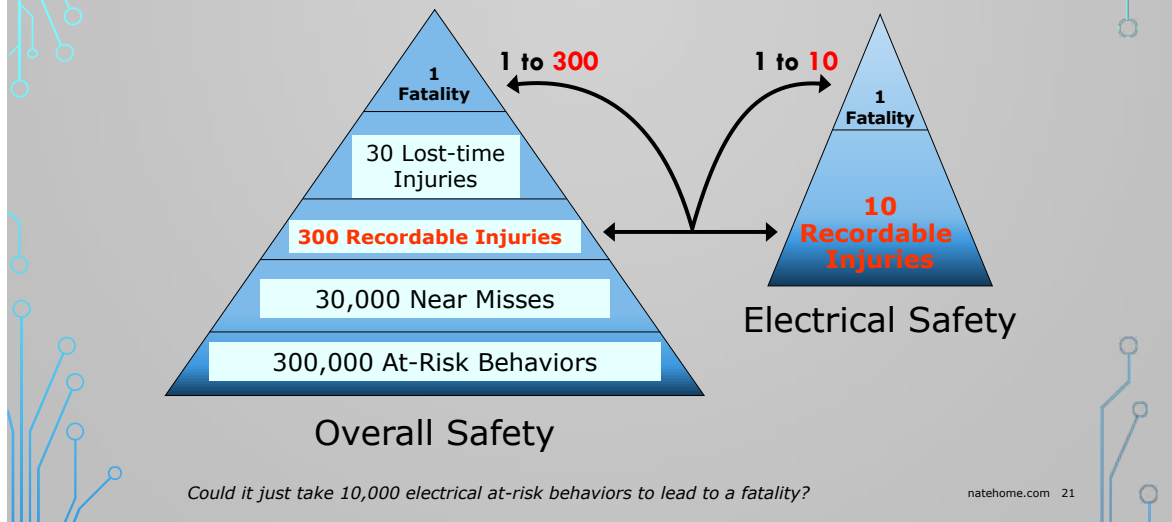
Burn Admissions Information based on data in National Burn Repository 2016 Report 2006-2015, Etiology, Cases in "Accident, Work Related Category"

Fire/Flame Injuries 9,356 (pg 78)

Electrical Injuries 3,575 (pg 93)

Link to access report: http://www.ameriburn.org/resources_publications.php

Importance of Electrical Safety



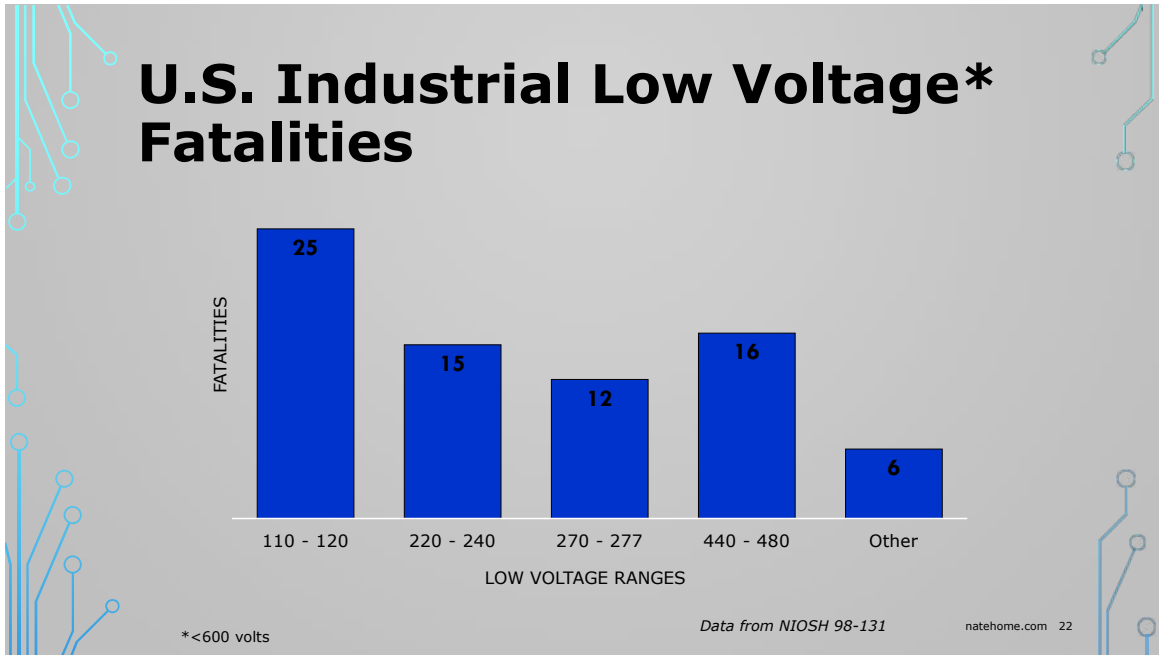
Most are familiar with the “safety pyramid”. As you can see from this pyramid, it often takes 300,000 unsafe acts to lead to one fatality; a company will have 300 recordable injuries before they have a fatality. This is relatively true in general safety.

Not wearing your hard hat can kill you but it is not as likely as not wearing your rubber gloves.

[CLICK to let the slide build]

In electrical safety it is a little different. From the EDF study, if those statistics hold, for every ten “recordable injuries” you will have a fatality. So, it might take as little as 30,000 at risk behaviors to lead to a fatality. See why electrical safety policies, procedures, audits and training are so important?

EXPERT: The statistics on electrical safety presented on this slide come from an Electric Department of France study cited on the previous slide. The Overall Safety pyramid is based on Professor Heinrich’s classic Oklahoma State University Study adapted to illustrate the statistics shown in the previous EDF study. Recordable in the classic OSHA sense may not be strictly what the EDF study implies but the basic principles are apparent in OSHA statistics since electrical safety is one of the top causes of fatalities.



This chart, created from a study done by NIOSH, shows most deaths from low voltage do not occur at the higher voltage of 480 volts and above.

Why do you believe this is true?

[Have class come up with list.]

[Answer] Several reasons explain this.

1. There is much more potential exposures to 120V.
2. Many unqualified people are not afraid of 120V but are afraid of higher voltages.
3. Many people do not realize 120V can kill you.
4. Electricians are more cautious with higher voltages.

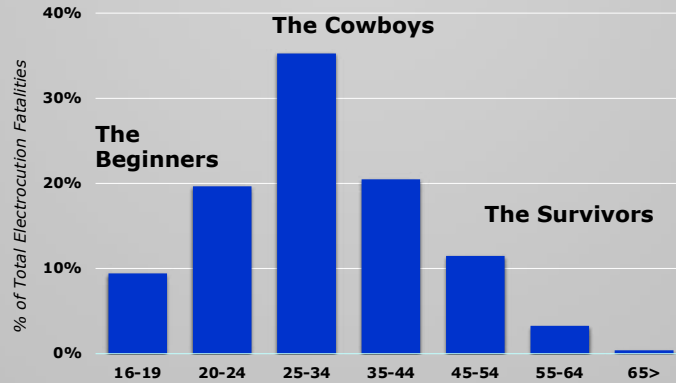
As this chart illustrates, ANY voltage is dangerous – even deadly.

These statistics come from those accidents investigated by NIOSH between 1982 and 1994. It does not represent them all, only a cross section of 74 deaths, identified as occurring at less than 600v.

When working around electricity of any voltage, do not become complacent.

Remember – electricity can and does kill.

Electrocution by Age



When we look at electrocutions by age, we see an interesting pattern. Most of the deaths don't occur with the workers who have the least experience.

[CLICK]

The “beginners” are often afraid or heavily supervised. Most of the deaths don't occur among the older folks.

[CLICK]

I'll call them “the survivors”.
Most deaths occur in the 25 to 34 age bracket.

[CLICK]

I'll call them “the cowboys.” You might think that is a little sexist, but studies have found that males in this age group who are extroverts are the most likely to be killed on the job. They are among the most intelligent workers too, but they get killed because they have two characteristics: they are risk takers (commonly a testosterone driven trait) and they want to please. Again, these are not all accidents, just those investigated in this NIOSH Study.

Also, note that we call them cowboys, not cowgirls, or renegades, this is deliberate. In this particular study there was only 1 female fatality and ...

EXPERT: Twenty-something, male, extroverts are the most likely to die on the job because they are the most likely to take risks. This was a statistic shared in the Electrical Safety Workshop 2010 from an Ontario study on electrical incidents and a psychological analysis of workers.

NATE STAR Initiative Data 2017-2021

Year	Electrical Deficiencies
2017	62
2018	36
2019	55
2020	53
2021	54
Total Deficiencies	260

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1. Employee #1 was working from an aerial lift, pulling slack from a fiber optic cable that his crew was installing on utility poles. He was tying mule tape to the fiber optic cable so the fiber optic cable could be secured on the pole for the evening. He tightened the mule tape by pulling his right hand over his head. His right hand contacted an energized 7,200-volt jumper, and he was electrocuted. https://www.osha.gov/pls/imis/establishment.inspection_detail?id=311820146
2. STERLING, IL – A telecommunications company worker was electrocuted while working on a utility pole. Another worker was injured and airlifted to the hospital where he was in critical condition. “What we know now is that they were working on the utility lines, pulling fiber-optic cable, and the bucket on the truck came into contact with the power lines,” Deputy Fire Chief Mike Dettman said. <https://www.saukvalley.com/2016/11/08/communications-worker-electrocuted-working-on-utility-pole/a7zyv3/>
3. 28-year-old tower technician was electrocuted while working on an AT&T LTE installation. Sources report, the technician came into contact with a 13kv power line while he was working on a residential rooftop. On Monday, technician working on a tower installation in Utica, MS, died when he fell from the structure. He was reportedly tied off to the waveguide ladder in 2 locations when it detached from the tower. <http://wirelessestimator.com/articles/2018/puerto-rico-death-is-second-industry-tower-tech-fatality-in-april/>
4. Telecom employees were installing and moving telecom lines. A worker touched a metal component that was in contact with the overhead power lines and was electrocuted. 2nd worker injured (shocked) trying to rescue victim. Event still under investigation. <https://www.cbs58.com/news/death-investigation-underway-near-84th-and-layton-in-greenfield>
https://www.osha.gov/pls/imis/establishment.inspection_detail?id=1439583.015

OSHA standard for Electrical Power Generation, Transmission, and Distribution; Electrical Protective Equipment, 29 CFR 1910.169 updated in 2014 are the most current guidelines for utilities. They adopted the NESC guidelines, but also have the force of law. 1910.268 was updated in 2016.

NESC is basically the NEC and NFPA 70E combined for utilities.

What Standards Apply?

Electric Power

2017 National Electrical Safety Code (NESC)
How to build AND work on utility systems

1910.269
Operation & Maintenance

1910.268
Telecommunications

1926 Subpart V
Construction

1926 Subpart M
Construction Fall Safety

Awareness of 1910.269 is Critical to the Telecom Worker

You MUST know which rules you are operating under

<https://www.osha.gov/laws-regs/standardinterpretations/2017-08-18>

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NESC is utility safety, NFPA 70E is non-utility electrical safety. You will likely follow one or the other or both.

OSHA standard for Electrical Power Generation, Transmission, and Distribution: Electrical Protective Equipment, 29 CFR 1910.269 updated in 2014 are the most current guideline for utilities. They adopted the NESC guidelines, but also have the force of law.

1910.268 was updated in 2016.

NESC is basically the NEC and NFPA 70E combined for utilities.

NFPA 70E “[Exclusions for railways, communications utilities and electric utilities to NFPA 70E to remain. Scope to remain within the NEC scope. NEC Technical Correlating Committee (TCC) established a Task Group to study the issue.]”

NOTE: Facilities which are not directly used for communications could be considered as part of NFPA 70E., i.e. offices.

SECTION 3

Basic Electrical Theory

- Arc Flash
- Static Electricity
- Ohm's Law - Current (I), Voltage (V), and Resistance (R)
- Electrical Circuit and Capacitor
- Alternating Current (AC)
- Direct Current (DC) and Rectifier
- Digital Multimeter (DMM)

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480V Arc Flash

Arc-blasts occur from high-amperage currents arcing through air.



Indirect contact with power can also result in a serious injury or death. An electrical arc can jump or “flash” between an energized object and a ground in the vicinity of an individual causing a severe flash burn to the exposed skin and clothing. The corresponding arc may also cause a flow of current through the tissue, resulting in the same type of injury as described previously.

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480-volt arc blast.

Arc-Blast. Arc-blasts occur from high-amperage currents arcing through air. This abnormal current flow (arc-blast) is initiated by contact between two energized points. This contact can be caused by persons who have an accident while working on energized components, or by equipment failure due to fatigue or abuse. Temperatures as high as 35,000°F have been recorded in arc-blast research. The three primary hazards associated with an arc-blast are:

Thermal Radiation. In most cases, the radiated thermal energy is only part of the total energy available from the arc. Numerous factors, including skin color, area of skin exposed, type of clothing have an effect on degree of injury. Proper clothing, work distances, and over current protection can improve the chances of curable burns.

Pressure Wave. A high-energy arcing fault can produce a considerable pressure wave. Research has shown that a person 2 feet away from a 25,000 amp arc would experience a force of approximately 480 pounds on the front of their body. In addition, such a pressure wave can cause serious ear damage and memory loss due to mild concussions. In some instances, the pressure wave may propel the victim away from the arc-blast, reducing the exposure to the thermal energy. However, such rapid movement could also cause serious physical injury.

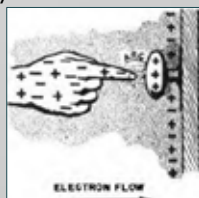
Projectiles. The pressure wave can propel relatively large objects over a considerable distance. In some cases, the pressure wave has sufficient force to snap the heads of 3/8-inch steel bolts and knock over ordinary construction walls. The high-energy arc also causes many of the copper and aluminum components in the electrical equipment to become molten. These “droplets” of molten metal can be propelled great distances by the pressure wave. Although these droplets cool rapidly, they can still be above temperatures capable of causing serious burns or igniting ordinary clothing at distances of 10 feet or more. In many cases, the burning effect is much worse than the injury from shrapnel effects of the droplets.

Static Electricity

Static Electricity – Electricity produced by friction is known as static electricity.

Like charges repel each other.

Unlike charges attract each other.



Lightning – is static electricity produced by the friction between air and water particles – a cloud picks up electrons and then discharges them to another cloud or back to earth.

Potential – Every charged object has a certain potential and when two charged objects have different potentials, electrons tend to move because of the potential difference. **Basically, potential differences cause electrons to flow.**

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Have you ever noticed that when someone combs their hair with a plastic comb you might see hair strands stand away from each other? You might hear a faint crackling sound and if it were dark, you might see tiny sparks as the comb moved through the hair.

The key to understanding frictional electricity is in the action between the hair and the plastic comb. As the hair strands lose electrons – they get “knocked loose” by the friction of the comb and it gives the hair a positive charge (loss of electrons gives the hair a positive charge).

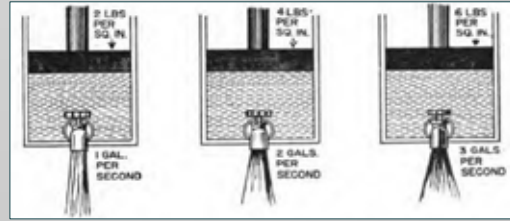
Discharging occurs when the attraction between two unlike charges is strong enough that electrons jump back to where they belong thus causing the faint crackling sound and sparks you saw.

I’m sure you’ve also experienced static electricity walking across a rug in rubber soled shoes and felt the discharge when you reached for the doorknob.

Ohm's Law

Ohm's Law – ratio of voltage to resistance.

$$I = V/R$$



Electrical current (I) – movement of charged particles such as electrons through a conductor or space (spark) measured in amperes (amp).

Voltage (V) – an electromotive force or potential difference that would drive one ampere of current against one ohm of resistance (in other words, the force that makes current flow).

$$V=IR$$

Resistance (R) – is a measure of the opposition to current flow in an electrical circuit.

$$R=V/I$$

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Think of current as electricity in motion or as water flowing through a pipe, – increasing the pressure in a water pipe increases the flow of water.

In any electrical circuit if you hold the resistance constant and increase the voltage, the current increases in proportion to the increase in voltage.

If you hold the resistance constant and decrease the voltage, the current decreases in proportion to the decrease in voltage.

In any electrical circuit if you hold the voltage constant and increase the resistance, the current decreases in proportion to the increase in resistance.

If you hold the voltage constant and decrease the resistance, the current increases in proportion to the decrease in resistance.

If the potential is large or resistance is small the conductor will allow strong current flows.

If the potential is small or resistance is large the conductor will allow little current flow.

Ohm's Law (continued)

Resistance (friction) depends on four factors:

1. Size of wire (smaller wire equals less flow or more resistance)
2. Length of wire (longer wire equals less flow or more resistance)
3. Kind of wire (iron has more resistance than silver or copper)
4. Temperature of the wire (resistance increases as temperature increases)

Conductor – a substance or material that allows electricity to flow through it

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A fundamental law of electricity is that as resistance in a wire is increased current is decreased. Put another way current is inversely proportional to resistance.

Good conductors are silver, copper, aluminum, brass, zinc, iron.

Poor conductors (insulators) – dry air, glass, mica, rubber, asbestos.

Electrical Circuit and Capacitor

Electrical Circuit – interconnection of electrical components which may consist of batteries, resistors, capacitors, switches, etc., that consists of a closed or complete loop.

Circuits – closed/complete – are in good working order (connections are clean and tight and decrease resistance).

Circuit Faults – Open, ground, or short can decrease or cut current flow (increase resistance) – typically caused by:

- Dirty connections – oil, grease, dust, corrosion;
- Loose connections – may spark, get hot and current will drop below its rated value;
- Vibrations cause loose connections, wear away insulation causing a short; or
- Wire breaks

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Electrical Circuit and Capacitor (continued)

Capacitor – Device for storing electrical energy, consisting of two conductors in close proximity and insulated from each other.

One way to think about a capacitor is to think of a water tank a town uses to store water – this accomplished two objectives – the water is stored and ready to use and by keeping it high above ground it has the potential or force to carry it to the consumer. The capacitor serves the same purpose with electricity.

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Digital Multimeter (DMM)

Digital Multimeter (DMM) – A multifunctional instrument or test tool meter that displays electrical quantitative values on an LCD screen. Similar to an analog meter, a digital multimeter is capable of reading current in amps, voltage in volts, and resistance in ohms.



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Voltage Detectors



A Foreign voltage detector is used to detect the presence of an electric field. Communications workers should test conductive surfaces in their work areas prior to conducting job tasks. The detectors should be checked on a known energized source prior to and after use.

Test:

- Ground wire
- Underground power conduit
- Any other potential electrical hazard, e.g. poles
- Un-insulated vertical grounds, electrical power guards, and conduits
- Street light fixtures and pole hardware
- Metal terminals and cabinets
- Grounds and bonds
- Metal fences

SECTION 3 KEY POINTS

1. Like charges repel each other and unlike charges attract each other (use proper PPE to prevent electron flow).
2. Ohm's law can determine resistance, voltage and current in a circuit.
3. Circuit faults create hazards that are typically caused by dirty, loose connections, insulation degradation or wire breaks.
4. Capacitors store electrical energy.
5. AC power is converted by rectifiers into DC power.
6. DMM's and voltage detectors are essential tools for determining potential electrical hazards.

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Measuring Clearance

Worker sticking a pole to measure NESC spacing to assure that the 40" worker telecom space is maintained. "Workers can utilize an insulated (tested) measuring stick or laser range finder."

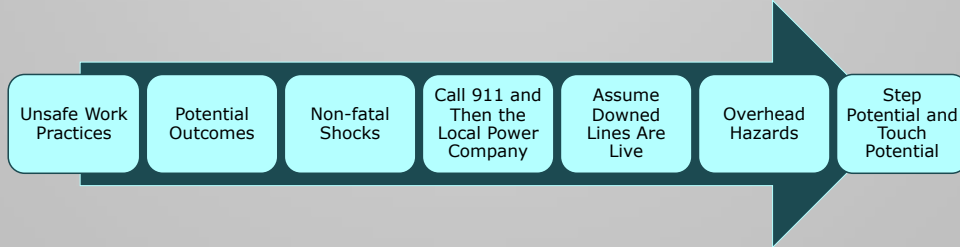


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5

What to Do in Case You Encounter or Make Contact With Downed Power Lines

SECTION 5
What to Do in Case You Encounter or Make Contact With Downed Power Lines



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Lined writing area consisting of 20 horizontal lines for notes or answers.

Unsafe Work Practices Can be Deadly!



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Non-fatal Shocks Can Result in Severe Burns



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Call 911 and Then the Local Power Company



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Always Assume Downed Lines Are Live

ALWAYS ASSUME ALL DOWNED LINES ARE LIVE

Downed power lines can be **deadly**. Always assume a downed power line is **live** and avoid approaching them or anything near them.

Use Precaution

Downed power lines can energize the ground up to **30 feet away**. Even more in wet conditions.

Never drive over downed power lines or anything in contact with them.

If you see a downed power line, call 911.

Never try to remove a downed power line.

If a vehicle contacts a downed line, it **could catch fire**.

STAY AWAY AND CALL 911

Consider all lines to be live and dangerous.

Stay in place or inside your vehicle unless you see fire or smoke.

Warn others to stay at least **35 feet away**.

Tell others not to approach vehicles, downed lines, or anything that may be in contact with downed lines.

Call 911.

In the Event of Fire or Smoke

Check for safety the ground and vehicle or the downed lines.

Jump from the vehicle or what you're on.

Don't touch anything until you're safe.

Call 911.

Please share this free content to save lives.

ES&S
www.facebook.com/ES&S.org
www.linkedin.com/company/ES&S.org
www.youtube.com/channel/UC8Wdmg

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Overhead Hazards

- Be alert to various overhead hazards
- Dangling power lines could be present
- Low-hanging tree limbs
- Articles dangling from trees
- Potential over-pass damages
- Always scan for any potential overhead concerns & avoid them

Keep yourself and the public safe!



Downed Power Line



New Jersey utility worker narrowly escapes power line fire.

Courtesy of Crown Castle

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<https://www.youtube.com/watch?v=VwSsK5FkHkw>
Courtesy of Crown Castle.

What Makes a Person Qualified...Electric Utility

Qualified employee (qualified person)

An employee (person) **knowledgeable in the construction and operation** of the electric power generation, transmission, and distribution equipment involved, along with the associated hazards.

Note 1: An employee **must have the training required** by (a)(2)(ii) of this section to be a qualified employee.

Only the employer can determine if someone is qualified.

1910.269 (x)

1910.269 (a)(2)(viii)

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What is a qualified person? For a Utility

If no one answers, have attendees turn to .269(x) You might ask someone in the class to read the definition.

First part comes up automatically.

[CLICK] ... Also, an employee in training... under direct supervision...

It is important to point out that this class does not make anyone qualified.

This class is for qualified persons or as part of a qualification process. It is only part of the safety training required as part of a qualification process.

Ultimately the employer decides if someone is qualified for any task. A license does not make one qualified. Training and evaluation of task specific skills and background knowledge determine qualifications.

Skills & Knowledge Required for a Qualified Person

Electric Utility Industry



- Precautionary techniques used for working around the hazards.
- Applicable electrical policies and procedures.
- Proper use of PPE, including arc flash, insulating, and shielding materials.
- Proper use of insulating tools and test equipment.
- Distinguish exposed, energized conductors and circuits from other parts of equipment.
- Determine nominal voltage.

OSHA 1910.269 (a)(2)(i-ii)

NFPA 70E 110.2(A)(1)

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A qualified person must have certain skills and knowledge. They include: **[read list]**

Your employer will define what makes a person at your organization qualified. The training requirements listed in 1910.269(a)(2)(i) and (ii) very closely resemble the NFPA 70E's training requirements for a qualified person (110.2 (A)(1)). This also will include training on equipment and work practices specific to your job and your company's electrical systems.

Skills & Knowledge Required for a Qualified Person

Telecommunications



- Rules are vague and left up to the employer.
- Training is allowed to be provided by the employer OR the employer can demonstrate that an employee is already trained in precautions and safe work practices prior to employment.
- Employer MUST certify each employee and have a certification record that includes the employee's name, signature of the trainer, and the date of training.
- This certification must be kept for the duration of employment.

OSHA 1910.268(C)

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For Telecommunications...

If You Make Contact

- Stay on the machine if possible
- Warn all others to stay away
- Notify power company immediately
- Attempt to move away but assure line is not "connected"
- Ground personnel are over 8 times more likely to be killed.
- Operators are normally safe if they stay on the equipment.

Bail Out Procedures

- If you must get out, jump with your feet together
- Do not touch the machine
- Hop or shuffle out of the area



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Aerial Equipment

Path to ground



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- Explain that aerial lift trucks represent a possible path to ground. Workers touching the truck can be injured or killed. Additionally, boom equipped trucks designed with controls mounted on the truck chassis and those equipped with pendant controls place the operator in direct contact with the ground. If an unintentional power line contact occurs, the operator is likely to sustain an injury. Injuries would occur from a shock. Electrocutation would result in death. Some manufacturers offer boom truck designs which place the operator on an elevated platform, isolated from the ground. Others incorporate pendant controls activated by radio frequency or fiber-optics. It is important to note that even when cranes are equipped with radio or fiber-optic controls, an operator can still sustain injury as current can flow through the ground, creating a hazard. If the boom is in an energized zone, do not touch the truck. Remember, the insulating bucket will not protect the operator from hand-to-hand contact with different potentials. Aerial lift trucks with insulated booms must be electrically tested on an annual basis. This helps ensure the insulating sections of the boom are in good condition.
- **Ask this question:** How could a worker on the ground be affected by a bucket truck contacting an overhead line? Electrocutation through touch potential.

Miscellaneous



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Pump Truck

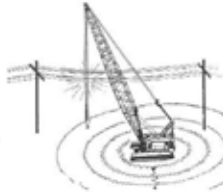


The concrete pump is designed to safely pump wet concrete through a delivery system of pipes and hoses.

Crane

The Ground May Be Hot!

- Electricity dissipates with the resistance of the ground
- As potential drops, fields develop around the electrified machine
- If you step across a line of unequal potential, you could be electrocuted



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Discuss the process of voltage dissipation by the resistance of the ground. Energy fields can be set up around the grounded object. If a person steps across two different levels of voltage or touches an object at a different level, electricity may pass through the body.

Excavating Equipment



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Rigging Systems



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Lockout/Tagout Principles

Control of Energy: All energy sources must be controlled so that employee exposure to electrical hazards is minimized.

Electrical Circuit Interlocks: Drawings or diagrams must be reviewed to ensure interlock devices are present which might re-energize the circuit.



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Energy sources can also be RF.

Energy Control Program

The employer shall establish a program consisting of:

- Energy control procedures
- Employee training
- Periodic inspections



Energy Control Program (continued)



- If an energy isolating device is not capable of being locked out, the employer’s energy control program shall utilize a “**tagout system.**”
- When a tagout device is used on an energy isolating device which is capable of being locked out.
 - Tagout device shall be attached at the same location.
 - Must provide equivalent safety.

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Energy Control LOTO Procedure

Energy control (LOTO) procedure

- Identify equipment/power source to be LOTO;
- Steps for shutting down, isolating, blocking and securing machines or equipment to control hazardous energy;
- Steps for the placement, removal and transfer of lockout devices or tagout devices, and the responsibility for them; **and**
- Requirements for testing machine/equipment to determine and verify effectiveness of LOTO devices and other energy control measures.

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Materials and Hardware – Locks and Tags

- Provided by employer
- Singularly identified
- Only device(s) used
- Not used for other purposes
- Durable
- Standardized
- Substantial
- Identifiable

Energy Isolation

Lockout or tagout shall be performed only by the **authorized employees** who are performing the servicing or maintenance.



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Application of Control

- Application of control
 1. Preparation for shutdown
 2. Machine or equipment shutdown
 3. Isolate all energy sources
 4. LOTO device application
 5. Release of stored energy
 6. Verification of isolation
- Know the types and amounts of energy
- Know the hazards of the energy
- Know method or means to control energy

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Use an example from industry or the light fixture in the meeting room.
(Talking point for #6) Talk about testing equipment to verify isolation.

Testing/Positioning Machines

When LOTO devices must temporarily be removed for testing/positioning:

- Clear machine or equipment of tools and materials
- Remove employees from area
- Remove lockout/tagout device
- Energize and proceed with testing or positioning
- Deenergize and reapply energy control measures

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Electricity



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Hazardous Conditions and Unsafe Acts

- Wet skin or damp ground.
- Defective tools, cords, and electrical installations.
- Working near overhead lines.
- Digging near underground utilities.
- Taking electrical related risks.
- Not respecting the ability of electricity to kill.

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OSHA Fatal Fact No. 57



He received an **electric shock** that killed him.

Worker was climbing a metal ladder to hand an electric drill to a worker above him.

- The extension cord had a **missing grounding prong** and a conductor on the green grounding wire was making intermittent contact with the energizing black wire thereby energizing the entire length of the grounding wire and the drill's frame.
- The drill was not double insulated.

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http://www.osha.gov/OshDoc/data_FatalFacts/f-facts57.html

Path of Least Resistance

- Electricity always follows through the path of least resistance.
- Creating an easy path for current that doesn't include your body.
- If your body becomes part of the path, electricity will flow through it.
- If that path is through vital organs like your heart and lungs you can die.

Estimated Effects of AC Currents (U.S. Standard 60 Hz)	
1 milliamp (mA)	Barely perceptible
16 mA	Maximum current an average man can grasp and "let go"
20 – 30 mA	Paralysis of respiratory muscles
100 mA	Ventricular fibrillation threshold
2 Amps	Cardiac standstill and internal organ damage
15/20/30 Amps	Common U.S. household breakers

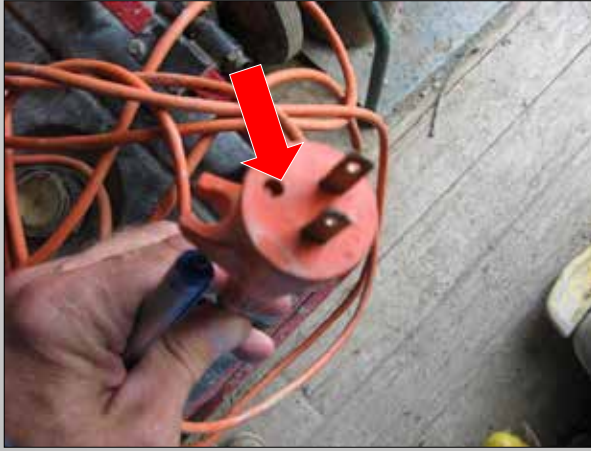
<http://www.cete.org/Trainer/GrndElecES.pdf>

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Instructors – Grounding and Bonding will be further discussed in Section 12.

<http://www.cete.org/Trainer/GrndElecES.pdf>

Danger! Missing Ground Prong



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Note: Defective cord.



Portable Generator

- Never attach a generator to the electrical system or a structure.
- Use three-pronged equipment or extension cords with the generator.
- Use GFCIs for employee protection.
- Ground the generator.
- Keep generator dry and away from standing water.

Taken from OSHA Fact Sheet located in the student workbook appendix.

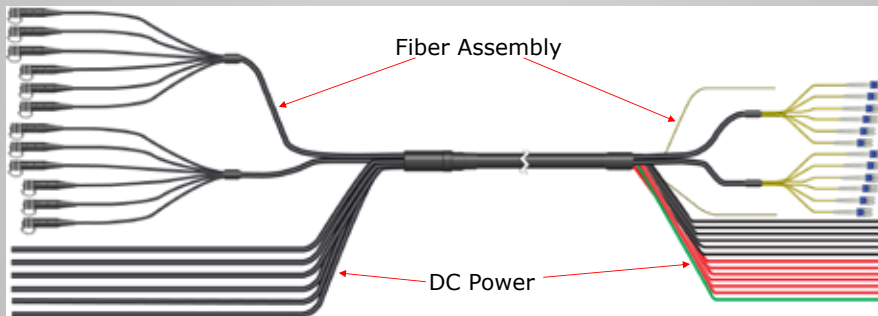
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Only qualified person can attach to system.

https://www.osha.gov/sites/default/files/publications/portable_generator_safety.pdf

Review OSHA Fact Sheet – located as an appendix on page 94-95 in the Student Workbook.

Hybrid Cable Assemblies



- Hybrid Cable Assemblies include DC and Fiber Cables and connectors
- They come with multiple conductor sizes and multiple configurations
- Confirm your installation has the proper gauge wire before installation

ALWAYS CONFIRM YOUR CONDUCTOR SIZE IN YOUR DESIGN DOCUMENTS

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<https://www.commscope.com/product-type/cable-assemblies/wireless-cable-assemblies/hybrid-fiber-power-cable-semblies/>

<https://www.commscope.com/product-type/cable-assemblies/wireless-cable-assemblies/hybrid-fiber-power-cable-assemblies/>

FDH1204-24SE2

Remote Radio Heads

A tower technician installs RRH (Remote Radio Heads) on a water tank exterior surface.

RRH's must have a transmission source for RF and a power source

- This can be AC or DC depending on the equipment
- Most are also fiber fed but can be copper



ALWAYS CONFIRM YOUR CONDUCTOR SIZE IN YOUR DESIGN DOCUMENTS

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Permanent Backup Generators

A permanent backup generator with a full-size diesel tank.

- Other options include:
 - Propane
 - Natural gas
- Most have an ATS or Automatic Transfer Switch
- Others may have an MTS or Manual Transfer Switch



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Stray Voltage Safety Alert

Stray Voltage at Telecommunications Supporting Structures

- This Safety Alert is being issued to inform contractors of potential electrical hazards at communications towers.
- Working on live electrical circuits can cause shocks, burns, explosions, and death.
- The purpose of the ground wire is to redirect the electrical flow through a pathway that safely dissipates the electrical current and stray electrical charge built-up within the equipment it is attached to.

Instructors – remind students that full Stray Voltage document is located in the Student Workbook on page 96.

SECTION 10 KEY POINTS

1. Always test before touch - utilize an FVD to ensure cabinets and other conductive parts are not energized.
2. Improper terminations, faulty cable, or defective equipment can cause stray voltage.
3. Workers installing electrical wiring and equipment need to be trained in the proper installation methods and procedures.
4. Maintain LOTO if required.

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Underground Power

SECTION 11 Underground Power

Call Before You Dig

- Always call 811
- Review state and jurisdictional requirements
(typically covers utilities within the right-of-way (ROW))
- Private locates when required
(there are third party locating companies that provide this service)
- Client/customer requirements

Locating Equipment

- Ground Penetrating Radar (GPR)
- Electromagnetic Locating Device

Potholing (Positively exposing underground utilities)

- Proper methods to physically locate facilities
- Soft dig methods

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Locating Equipment



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Potholing and Ground Penetrating Radar (GPR)

Potholing is a method of visually locating a facility by hand digging or soft dig methods.



Hand digging is suitable for applications where working space is limited and access restricted.

GPR is a piece of equipment that uses radar to identify underground facilities.



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Potholing picture on the left – qualifies as a soft dig.

Hand digging is generally considered a safe method of potholing, as the equipment used is not likely to rupture an underground pipe. However, caution should be exercised when digging near to electrical lines and fiber optics.

SECTION 12 Grounding and Bonding

Grounding

Bonding

Dalziel's Table

Earth Grounding for Worker Protection

Grounding for Equipment

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Grounding

Grounds create a zone of equalized potential for equipment and personnel.

The purpose of the **ground** is:

- a reference point in an electrical circuit from which voltages are measured;
- a common return path for electric current;
- a direct physical connection to the Earth;
- backup pathway that provides an alternate route for the current to flow back to the ground if there is a fault in the wiring system; and
- **to protect users from electrical shock hazard.**

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Bonding is the connecting of two or more objects together using conductive wire for the purpose of equalizing electrical energy. When electrical energies are not equal, a current is established and can cause a shock. Thus, when working with ground and bonding wires on telecommunications sites, there is the potential for the ground or bond wires to be energized with voltage and current levels that could cause an electrical shock or burn hazard. The current levels can be sufficient to cause electrical shocks and thermal burns even at low voltages below 50vdc.

Bonding

Bonding is electrically connecting two or more pieces of communication hardware or connecting communication hardware to hardware belonging to another utility to maintain a common electrical potential. Bonding conductors must be of sufficient gauge to carry anticipated current in the event of a power contact.

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The instructor should engage the crowd in understanding the difference between bonding and grounding. Should notate that ground wire theft is common in the industry.

Dalziel’s Table Deleterious Effects of Electric Shock



Body Effect	Gender	60 HZ AC
Slight sensation at point(s) of contact	Men	.0004 Amps
	Women	.0003 Amps
Pain with voluntary muscle control maintained	Men	.009 Amps
	Women	.006 Amps
Pain with loss of voluntary muscle control	Men	.016 Amps
	Women	.0105 Amps
Severe pain and breathing difficulty	Men	.023 Amps
	Women	.015 Amps
Possible heart fibrillation after 3 seconds	Men	1/10 Amps
	Women	1/10 Amps

Designed by Crown Castle for Safety Training. Charles F. Dalziel, Deleterious Effects of Electric Shock natehome.com 135

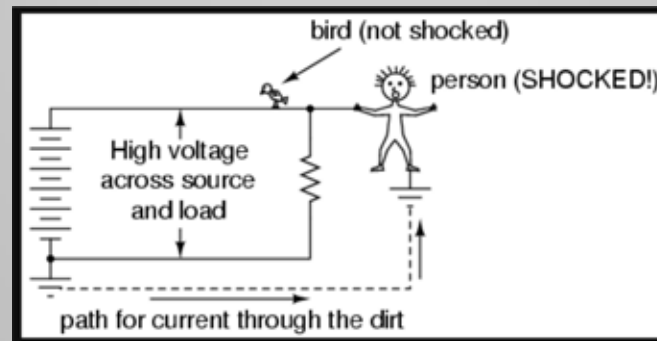
Designed by Crown Castle for Safety Training. Charles F. Dalziel, Deleterious Effects of Electric Shock

Charles Dalziel’s experimentation conducted at the University of California (Berkeley) began with a state grant to investigate the bodily effects of sub-lethal electric current. His testing method was as follows: healthy male and female volunteer subjects were asked to hold a copper wire in one hand and place their other hand on a round, brass plate. A voltage was then applied between the wire and the plate, causing electrons to flow through the subject’s arms and chest. The current was stopped, then resumed at a higher level. The goal here was to see how much current the subject could tolerate and still keep their hand pressed against the brass plate. When this threshold was reached, laboratory assistants forcefully held the subject’s hand in contact with the plate and the current was again increased. The subject was asked to release the wire they were holding, to see at what current level involuntary muscle contraction (tetanus) prevented them from doing so. For each subject the experiment was conducted using DC and also AC at various frequencies. Over two dozen human volunteers were tested, and later studies on heart fibrillation were conducted using animal subjects.

Lined area for notes or student responses, consisting of approximately 15 horizontal lines.

Grounding

Electrically connecting communication hardware to an effective electrical ground.



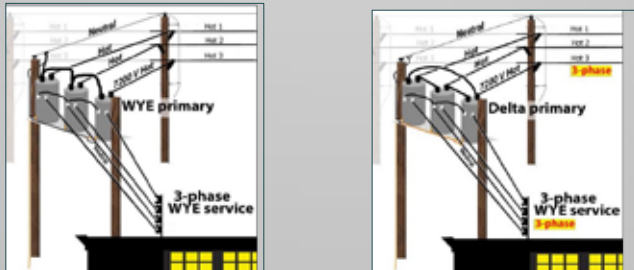
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- **Grounding is** electrically connecting communication hardware to an **effective electrical ground**. An effective electrical ground can be a power system MGN, (Multi grounded Neutral) a grounded neutral of a secondary power system with at least three customer services connected, a metallic water system, an extensive underground or buried cable system, or a specially constructed grounding network.
- An **effective electrical ground** is a low-impedance ground, such as the power MGN, that is low enough to operate protective equipment. Electrical connection to a low-resistance ground permits electric current to discharge to ground without the buildup of hazardous voltages on the communication plant in case of electrical contact.

Grounding for Equipment

Two Systems:

- 1. WYE (multi-grounded neutral)
- 2. Delta



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Quick way to identify WYE or DELTA

Applies to primary side of 3-transformer installation.

Three hot wires will drop down from overhead power lines.

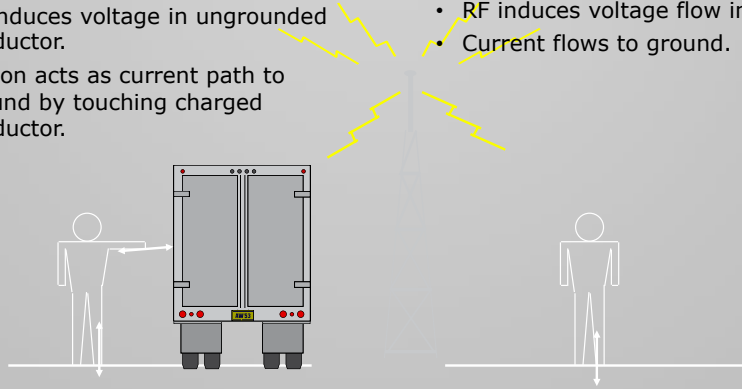
If each drop wire connects to only one transformer, then that connection is WYE.

If each drop wire connects to 2 different transformers, then that connection is DELTA.

Induced and Contact Currents

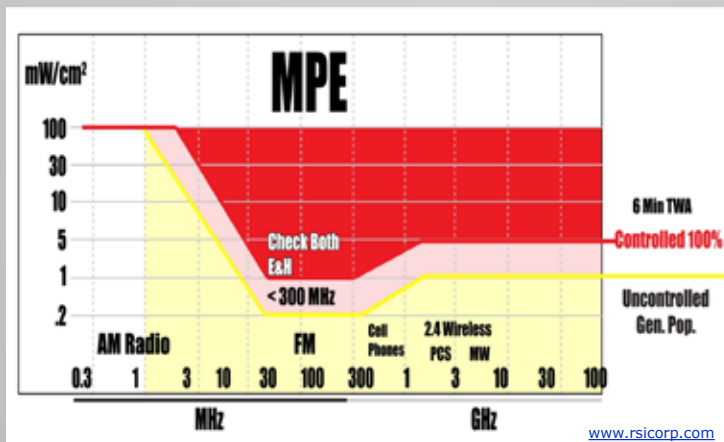
Two Scenarios:

- RF induces voltage in ungrounded conductor.
- RF induces voltage flow in person.
- Current flows to ground.
- Person acts as current path to ground by touching charged conductor.



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FCC Maximum Permissible Exposure (MPE) Rule



You will see this chart often. What you need to know is there are two levels: Controlled/occupation and uncontrolled/general population. We will go into these further in this class. The 30-300 MHz frequency is the most stringent as this frequency wave more closely resembles the height of a human, so absorption is easier/faster.

All you need to know is what % of standard you are exposed to. Since you are trained you can now be exposed to 100% of the standard and work in that area all day. If you were not trained, you could only be exposed to 20% of the controlled standard or the yellow line.

Body Heating

- RF **over**exposure could heat jewelry and metal on clothing.
- It could affect medical implanted devices.



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A tower tech was telling us a story about his tattoo turning into a brand. He was climbing the tower and his tattoo began to itch. Then it got red and finally it started to blister. Evidently it had iron in the dye and on a hot RF site it was heating the iron. The black outline blistered, and he now has a tattoo with a scar in the area of the outline.

Electromagnetic Energy Exposure (EME)

EME exposure is **non-accumulative**, if exposure is kept below published regulatory guideline 47 CFR 1.1310.

This means EME exposure does not build up in the body the way ionizing radiation can.

Depending on frequency, the ability of RF energy to heat varies greatly. Even in the cases of severe exposure to high energy levels, if the individual **removes him or herself** from the RF environment, the human body which is an excellent "radiator" **will cool itself** through biological processes in a short period of time.

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<https://www.govinfo.gov/content/pkg/CFR-2020-title47-vol1/xml/CFR-2020-title47-vol1-sec1-1310.xml>

Title 47 - Telecommunication

Volume: 1 Date: 2020-10-01 Original Date: 2020-10-01 Title: Section Â§ 1.1310 - Radiofrequency radiation exposure limits. Context: Title 47 - Telecommunication. CHAPTER I - FEDERAL COMMUNICATIONS COMMISSION. SUBCHAPTER A - GENERAL. PART 1 - PRACTICE AND PROCEDURE. - Grants by Random Selection. Subpart I - Procedures Implementing the National Environmental Policy Act of 1969.

§ 1.1310 Radiofrequency radiation exposure limits.(a) Specific absorption rate (SAR) shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in § 1.1307(b) of this part within the frequency range of 100 kHz to 6 GHz (inclusive).(b) The SAR limits for occupational/controlled exposure are 0.4 W/kg, as averaged over the whole body, and a peak spatial-average SAR of 8 W/kg, averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the parts of the human body treated as extremities, such as hands, wrists, feet, ankles, and pinnae, where the peak spatial-average SAR limit for occupational/controlled exposure is 20 W/kg, averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). Exposure may be averaged over a time period not to exceed 6 minutes to determine compliance with occupational/controlled SAR limits.

Induced Current – AM Tower

Crane is close to an AM tower, when they lowered the hook and it got to a certain point the trolley took off, goes to the end of the boom and hits the e-stop. The operator does not know what was wrong but found the trolley contacts welded closed. They fix them and start up again, lower the hook, the trolley takes off and goes to the end of the boom.

When the cables get to a point, they resonate with the AM station the crane has an induced current strong enough to weld the contacts together. The crane becomes a passive repeater.



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The crane is close to an AM tower, when they lower the hook and it gets to a certain point the trolley takes off, goes to the end of the boom, and hits the e-stop. They do not know what is wrong, but they find the trolley contacts welded closed. They fix them and start up again, lower the hook, the trolley takes off and goes to the end of the boom.

The issue is that when the cables get to a point, they resonate with the AM station the crane has an induced current strong enough to weld the contacts together. The crane actually becomes a passive repeater.

Any conductive (metal) object in close proximity of a high-power RF field can exhibit the potential for a strong shock or burn. You must do testing in order to verify that there is not a buildup of current that could pose a shock or burn hazard. Close proximity is within 3 KM is 1.8 miles.

1926.1408 (f) - When working near transmitter / communication towers where the equipment is close enough for an electrical charge to be induced in the equipment or materials being handled, the transmitter must be deenergized or the following precautions must be taken:

- (f) (1) The equipment must be provided with an electrical ground.
- (f) (2) If tag lines are used, they must be non-conductive.

Insulated Tools – Industry Best Practice



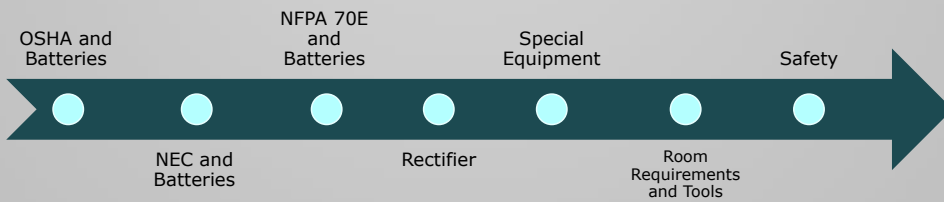
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Best practice any time working on electrical equipment whether energized or de-energized. Please refer to your company policy or training guidelines.

Battery Safety

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SECTION 15 Battery Safety



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INSTRUCTOR MANUAL

Electrical Safety Awareness for Telecom Workers Training Course

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More on OSHA® and Batteries

29CFR Part 1910 (continued)

- 1910.151 – Eyewash

- OSHA interpretation letters refer you to ANSI Z358.1,
- which requires 15-minutes eyewash station (plumbed or not).



- Plumbed eyewash stations require weekly maintenance per ANSI Standard.



- Recommendation of eyewash bottles.

(For sealed batteries with explosion proof vents)



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29 CFR 1910.268(b)(2)(i) doesn't have an associated interpretation letter giving an exemption for an emergency eyewash for telecom employers. This is what is written in (b)(2)(i): "Facilities for quick drenching or flushing of the eyes and body shall be provided unless the storage batteries are of the enclosed type and equipped with explosion proof vents, in which case sealed water rinse or neutralizing packs may be substituted for the quick drenching or flushing facilities." My interpretation of that is that if the battery is enclosed (sealed) and has explosion proof vents, an emergency eyewash or shower is not required. If it doesn't meet those characteristics, suitable facilities must be available (plumbed or self-contained). Eyewash bottles do not meet the criteria required under 29 CFR 1910.151 for emergency flushing facilities.

NFPA 70E and Batteries

Electrical Safety in the Workplace

- Not law but is the reference for the OSHA Electrical Safety Rules (29CFR parts 1910 and 1926), which are law.
- Electrical insulating gloves not required for nominal 50V or less.



- Arc Flash generally not required for nominal 50V or less.
- General Telecom Equipment is typically -48V DC.

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OSHA[®] FactSheet

Using Portable Generators Safely

Portable generators are internal combustion engines used to generate electricity. They are useful when temporary or remote power is needed, and are commonly used during cleanup and recovery efforts following disasters such as hurricanes, tornadoes, etc. This fact sheet discusses specific hazards inherent with the use of generators and also provides helpful information to ensure that workers and others using such equipment remain safe.

Hazards Associated with Generators

- Shocks and electrocution from improper use of power or accidentally energizing other electrical systems.
- Carbon monoxide from a generator's exhaust.
- Fires from improperly refueling a generator or inappropriately storing the fuel for a generator.
- Noise and vibration hazards.

Shock and Electrocution

The electricity created by generators has the same hazards as normal utility-supplied electricity. It also has some additional hazards because generator users often bypass the safety devices (such as circuit breakers) that are built into electrical systems. The following precautions are provided to reduce shock and electrocution hazards:

- Never attach a generator directly to the electrical system of a structure (home, office, trailer, etc.) unless a qualified electrician has properly installed the generator with a transfer switch. Attaching a generator directly to a building electrical system without a properly installed transfer switch can energize wiring systems for great distances. This creates a risk of electrocution for utility workers and others in the area.
- Always plug electrical appliances directly into the generator using the manufacturer's supplied cords or extension cords that are grounded (3-pronged). Inspect the cords to make sure they are fully intact and not damaged, cut or abraded. Never use frayed or damaged extension cords. Ensure the cords are appropriately rated in watts or amps for the intended use. Do not use underrated

cords—replace them with appropriately rated cords that use heavier gauge wires.

Do not overload a generator; this can lead to overheating which can create a fire hazard.

- Use ground fault circuit interrupters (GFCIs), especially where electrical equipment is used in or around wet or damp locations. GFCIs shut off power when an electrical current is detected outside normal paths. GFCIs and extension cords with built-in GFCI protection can be purchased at hardware stores, do-it-yourself centers, and other locations that sell electrical equipment. Regardless of GFCI use, electrical equipment used in wet and damp locations must be listed and approved for those conditions.
- Make sure a generator is properly grounded and the grounding connections are tight. Consult the manufacturer's instructions for proper grounding methods.
- Keep a generator dry; do not use it in the rain or wet conditions. If needed, protect a generator with a canopy. Never manipulate a generator's electrical components if you are wet or standing in water.
- Do not use electrical equipment that has been submerged in water. Equipment must be thoroughly dried out and properly evaluated before using. Power off and do not use any electrical equipment that has strange odors or begins smoking.

Carbon Monoxide Poisoning

Carbon monoxide (CO) is a colorless, odorless, toxic gas. Many people have died from CO poisoning because their generator was not adequately ventilated.

- Never use a generator indoors or in enclosed spaces such as garages, crawl spaces, and basements. NOTE: Open windows and doors may NOT prevent CO from building up when a generator is located in an enclosed space.
- Make sure a generator has 3 to 4 feet of clear space on all sides and above it to ensure adequate ventilation.
- Do not use a generator outdoors if its placement near doors, windows, and vents could allow CO to enter and build up in occupied spaces.
- If you or others show symptoms of CO poisoning—dizziness, headaches, nausea, tiredness—get to fresh air immediately and seek medical attention. Do not re-enter the area until it is determined to be safe by trained and properly equipped personnel.
- Keep portable generators as far away as possible from work areas and gathering spaces.
- Wear hearing protection if this is not possible.

Workers' Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

For additional information, see [OSHA's Workers page \(www.osha.gov/workers\)](http://www.osha.gov/workers).

How to Contact OSHA

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing safe and healthful workplaces for their employees. OSHA's role is to help ensure these conditions for America's working men and women by setting and enforcing standards, and providing training, education, and assistance. For more information, visit www.osha.gov or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

Fire Hazards

- Generators become hot while running and remain hot for long periods after they are stopped. Generator fuels (gasoline, kerosene, etc.) can ignite when spilled on hot engine parts.
- Before refueling, shut down the generator and allow it to cool.
- Gasoline and other generator fuels should be stored and transported in approved containers that are properly designed and marked for their contents, and vented.
- Keep fuel containers away from flame producing and heat generating devices (such as the generator itself, water heaters, cigarettes, lighters, and matches). Do not smoke around fuel containers. Escaping vapors or vapors from spilled materials can travel long distances to ignition sources.
- Do not store generator fuels in your home. Store fuels away from living areas.

Noise and Vibration Hazards

- Generator engines vibrate and create noise. Excessive noise and vibration could cause hearing loss and fatigue that may affect job performance.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.



OSHA[®] Occupational Safety and Health Administration

DTSEM FS-3286 09/2005

SAFETY DEPARTMENT

SAFETY ALERT

FOR EXTERNAL USE



Alert 2021-03

Stray Voltage at Telecommunications Supporting Structures

This Safety Alert is being issued to inform contractors of potential electrical hazards at communications towers. In 2019 OSHA recorded 166 fatal electrical injuries and 43% of those were in the construction industry. With any electrical system, there is the potential for hazards. Installations in close proximity to power lines, improper installation methods and wiring connections, faulty electrical equipment and the lack of knowledge and training in electrical safety can lead to workers being exposed to electrical hazards.

Working on live electrical circuits can cause shocks, burns, explosions, and death. Live circuits should be de-energized and have a Lock Out / Tag Out (LOTO) performed whenever possible. All electrical wires, including grounding wires should be treated as energized as stray voltage and current may be present. Caution must be exercised when connecting and disconnecting electric leads as this activity may cause an electrical shock hazard and may also create an electric arc. Grounding wires are also potential current carrying conductors and may expose workers to the hazards discussed.

The purpose of the ground wire is to redirect the electrical flow through a pathway that safely dissipates the electrical current and stray electrical charge built-up within the equipment it is attached to. Bonding is the connecting of two or more objects together using conductive wire for the purpose of equalizing electrical energy. When electrical energies are not equal, a current is established and can cause a shock. Thus, when working with ground and bonding wires on telecommunications sites, there is the potential for the ground or bond wires to be energized with voltage and current levels that could cause an electrical shock or burn hazard. The current levels can be sufficient to cause electrical shocks and thermal burns even at low voltages below 50vdc.

Most electrical accidents result from one of the following three factors:

- unsafe equipment or installation,
- unsafe environment,
- unsafe work practices.

Some ways to prevent these accidents such as LOTO through deenergizing the electric equipment before inspection or repair, exercising caution when working near energized lines, using safe work practices and appropriate protective equipment. Conductive components should be tested prior to working on them or touching them to help ensure worker safety. When stray voltage is found it may be necessary to contact a qualified electrical worker to investigate the source of the stray voltage and to conduct repairs.

It is the responsibility of employers to develop safe working procedures for their employees and to train their employees how to work safely around electrical systems and LOTO. As per NFPA 70e, only Qualified Electrical Workers may work on live electrical equipment over 50V. Electrical safety-related work practice requirements for general industry are detailed in Subpart S of 29 CFR Part 1910, in Sections 1910.331–1910.335. For construction applications, electrical safety-related work practice requirements are detailed in Subpart K of 29 CFR Part 1926.416 to 1926.417. State Plans and local codes may dictate additional electrical safety requirements and training.



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