



ELECTRICAL SAFETY AWARENESS FOR TELECOM WORKERS

**U.S. Department of Labor - OSHA
Susan Harwood Grant
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Acknowledgement

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Disclaimer/Usage Notes

- After the completion of this course, please refer to your company policies and procedures.
- It is not the intent of the content developers to provide compliance-based training in this presentation, the intent is more to address electrical safety awareness in the telecom industry, and to recognize the overlapping hazards present in many construction workplaces.
- It is the responsibility of the employer, its subcontractors, and its employees to comply with all pertinent rules and regulations in the jurisdiction in which they work.
- Copies of all OSHA regulations are available from your local OSHA office, and many pertinent regulations and supporting documents have been provided with this presentation in printed format.

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.

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.

Training Topic Sections 1-8

Section	Title
Section 1:	Introduction to NATE and OSHA
Section 2:	Industry Statistics Related to Telecom-Related Electrical Work
Section 3:	Basic Electrical Theory
Section 4:	Overhead Transmission and Distribution
Section 5:	What to Do in Case You Encounter or Make Contact With Downed Power Lines
Section 6:	Qualified Person
Section 7:	Equipment
Section 8:	Lockout/Tagout

Training Topic Sections 9-17

Section	Title
Section 9:	Hand Tools and Portable Generators
Section 10:	Installation of Electrical Telecom Equipment
Section 11:	Underground Power
Section 12:	Grounding and Bonding
Section 13:	Induced Current
Section 14:	Personal Protective Equipment (PPE)
Section 15:	Battery Safety
Section 16:	Tower Lighting and Capacitors
Section 17:	Summary

SECTION 1

Introduction to NATE and OSHA



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.



THE COMMUNICATIONS INFRASTRUCTURE
CONTRACTORS ASSOCIATION

About OSHA

On December 29, 1970, President Nixon signed the **Occupational Safety and Health Act of 1970 (OSH Act)** into law. The OSH Act created the **Occupational Safety and Health Administration (OSHA)** to ensure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance.



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.

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

Workers Have the Right to

- Safe and healthful working conditions;
- File a confidential complaint with OSHA in regard to safety and/or health concerns in the workplace;
- Review records of work-related injuries and illnesses;
- Receive training regarding the OSHA standards that apply to their workplace;
- Report any injury or illness without retaliation or discrimination;
- Right to access employee exposure records, employee medical records, and analyses based upon employee exposure records or medical records.
- Obtain copies of their medical records.

Employees Must

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.

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

OSHA Whistleblower Protection

- Visit [osha.gov/workers](https://www.osha.gov/workers) or call 800-321-OSHA (6742);
- Be prepared to provide specific details regarding your company and the type of hazard or discrimination being reported;
- Keep a confidential record of all details; and
- Once a complaint is filed or reported, an investigation is normally warranted (see criteria on website).

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

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).

SECTION 2

Industry Statistics Related to Telecom-Related Electrical Work

Disclaimer	Electrical Safety Foundation International Report	By the Number	Importance of Electrical Safety
U.S. Industrial Low Voltage Fatalities	Electrocution by Age	NATE STAR Initiative Data	Why Be Concerned About Electrical Safety
What Standards Apply			

Disclaimer

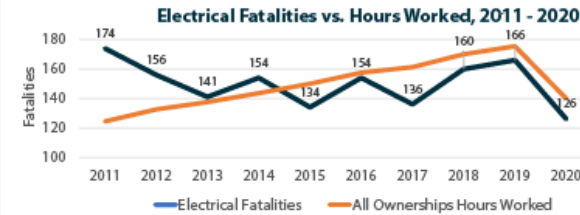
This awareness training does not qualify you to handle electrical power lines and power company equipment. You must be an electrically qualified person to work on electrical lines and equipment.

Electrical Safety Foundation International (ESFI) Report

WORKPLACE ELECTRICAL INJURIES: 2011 - 2020

126
FATAL ELECTRICAL INJURIES IN 2020

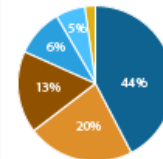
According to the Bureau of Labor Statistics, 2020 had the fewest number of electrical fatalities since 2003. There was a **24% decrease over 2019**. Nonfatal electrical injuries involving days away from work totaled 2,220 in 2020, a **17% increase over 2019**. Total hours worked decreased by 10% in 2020.



Electrical Fatalities Statistics

- Contact with / exposure to electric current accounted for 2.6% of all fatalities in 2020
- In 2020, 5.3% of all electrical incidents were fatal
- Hispanic or Latino workers accounted for 40% of electrical fatalities

Occupations Involved in Electrical Fatalities



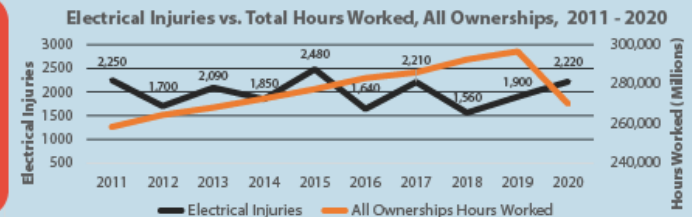
- Construction and Extraction: 44%
- Installation, Maintenance, Repair: 20%
- Building and Grounds Cleaning & Maintenance: 13%
- Transportations & Material Moving: 6%
- Management: 5%
- Farming, Fishing, Forestry: 3%

Fatality Rate

The mining industry had the **highest rate** of fatal electrical injuries (**0.8 / 100,000**) followed by **construction (0.6 / 100,000)**. All industries had 0.1 fatalities per 100,000 workers.

Electrical Injuries Statistics

- 31% of electrical injuries occurred in Installation, Maintenance, and Repair occupations.
- 65% of injuries occurred in service-providing industries. 35% occurred in good-producing industries
- 63% of those injured were working for their employer for 1+ years



Please share this free resource to save lives



www.facebook.com/ESFI.org



www.twitter.com/ESFIdotorg



www.youtube.com/ESFIdotorg

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



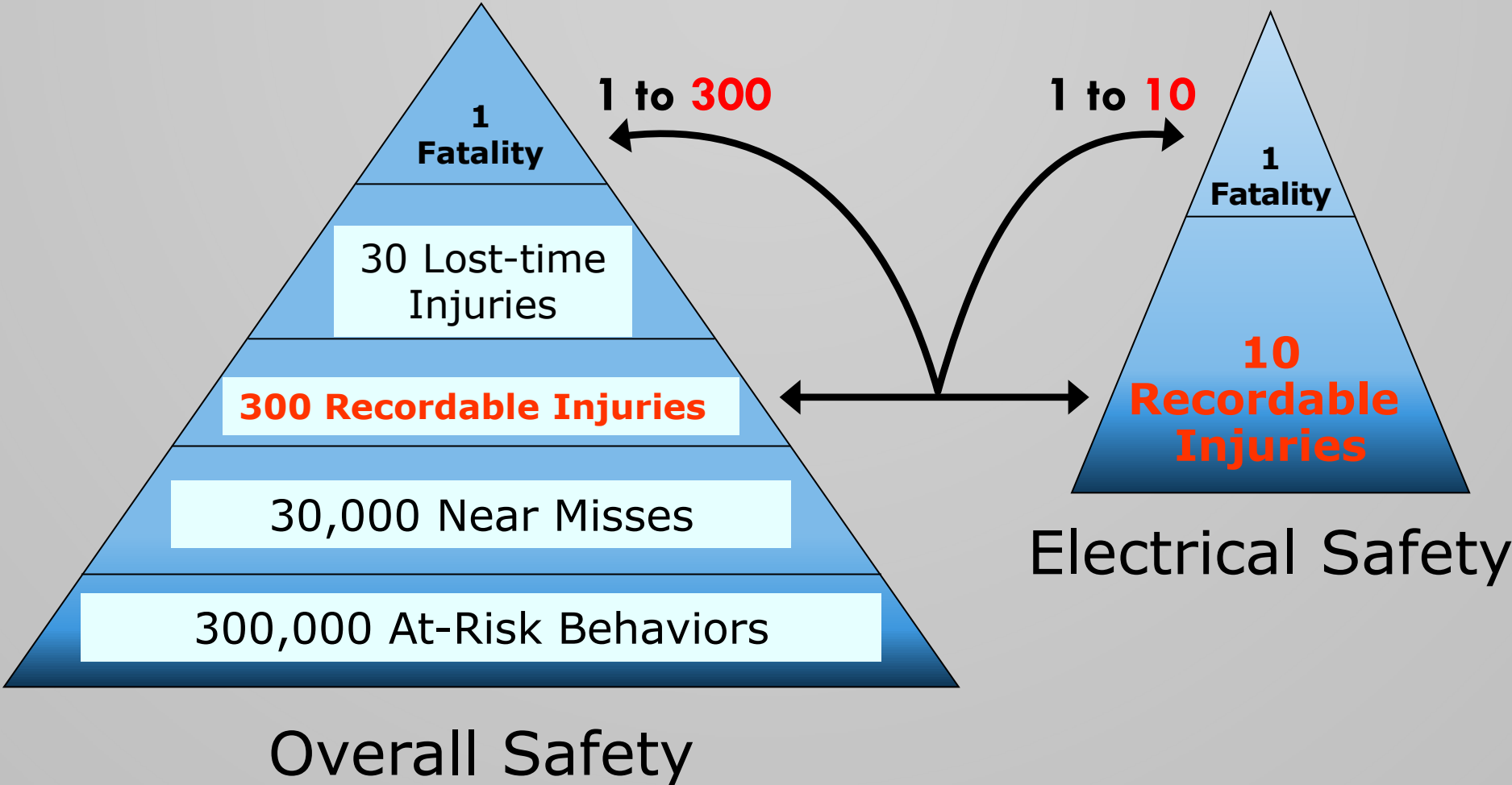
Every other day

1

Worker is electrocuted

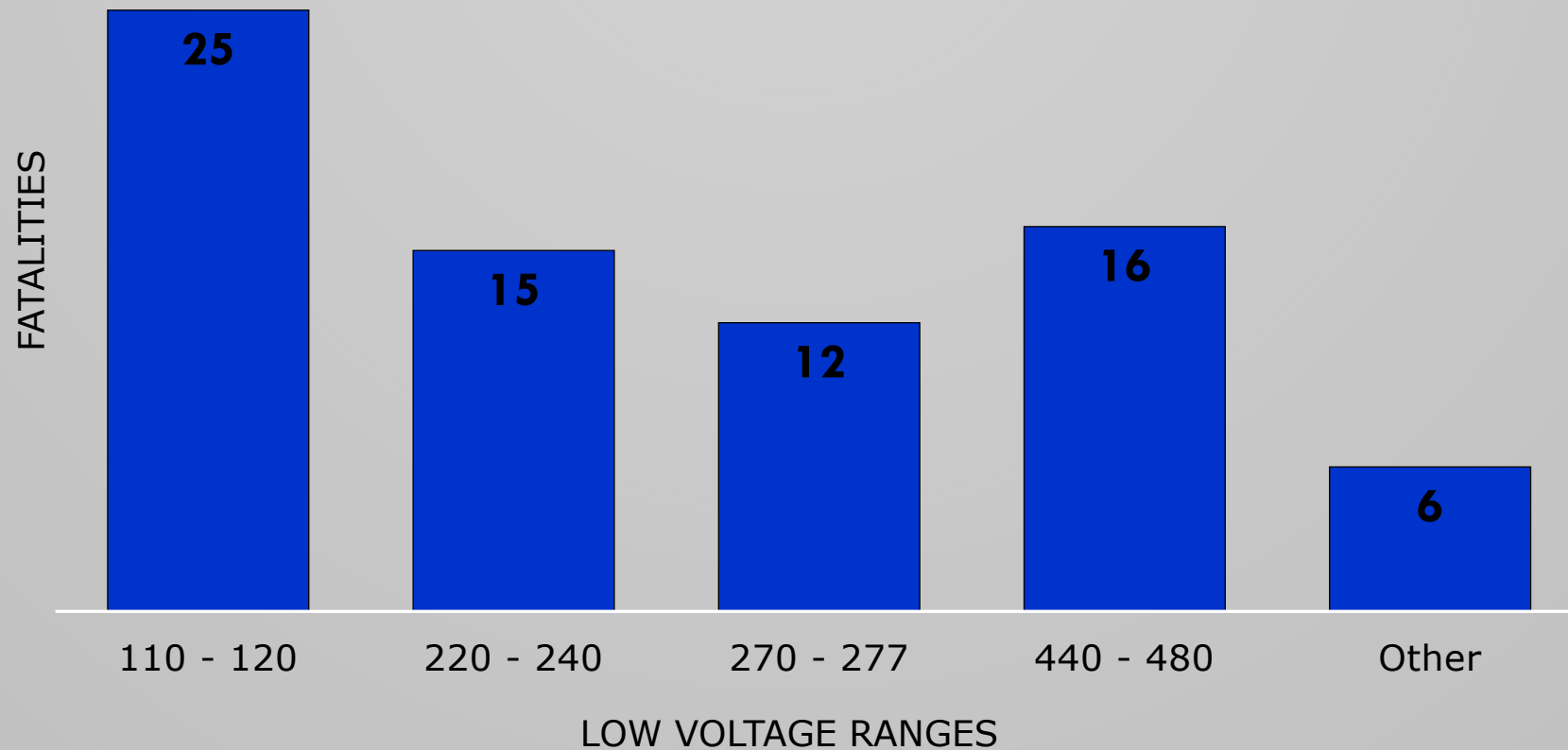
* Based on NBR 2016 Report data **2005-2014, bls.gov

Importance of Electrical Safety



Could it just take 10,000 electrical at-risk behaviors to lead to a fatality?

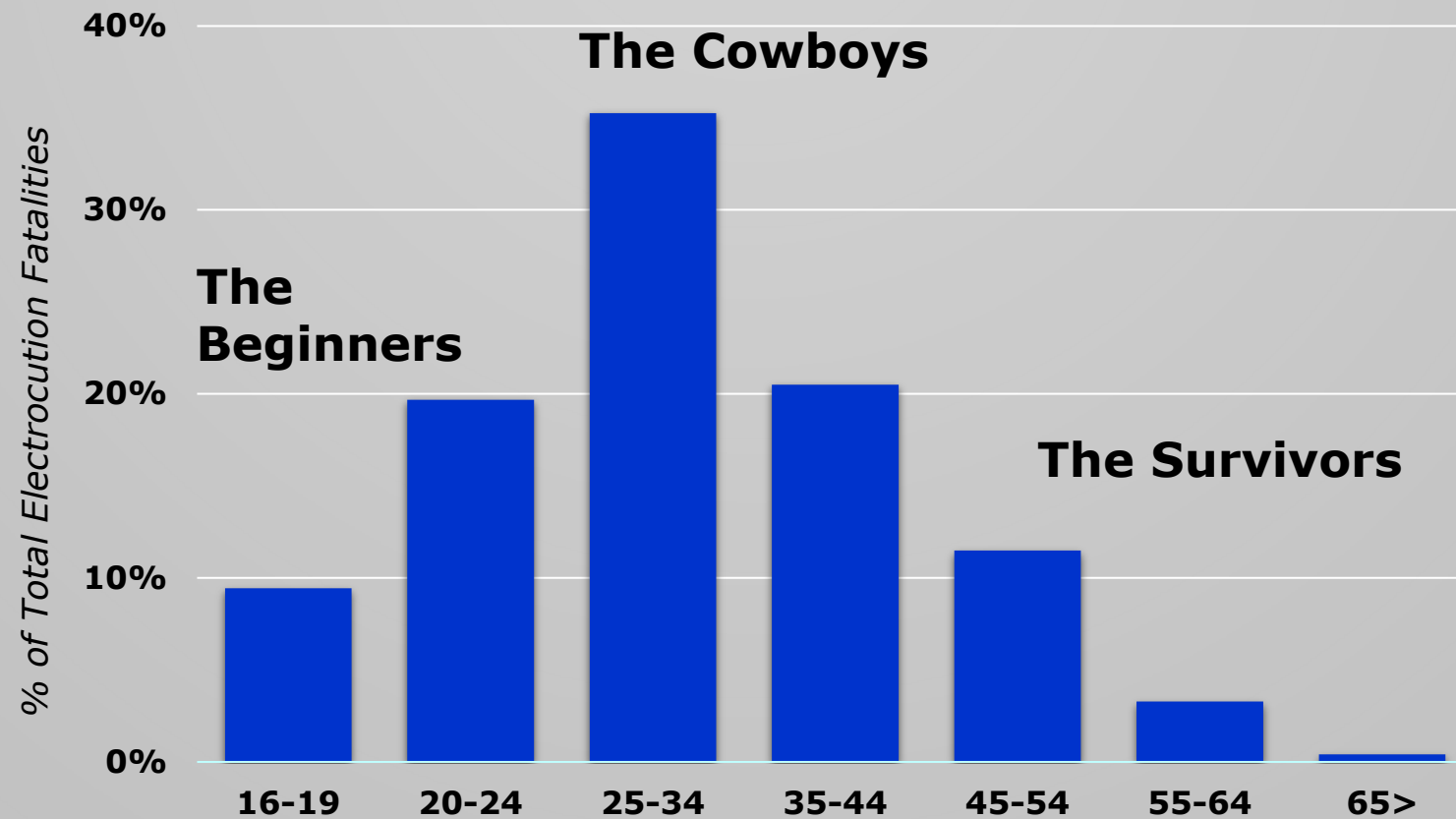
U.S. Industrial Low Voltage* Fatalities



* <600 volts

Data from NIOSH 98-131

Electrocution by Age



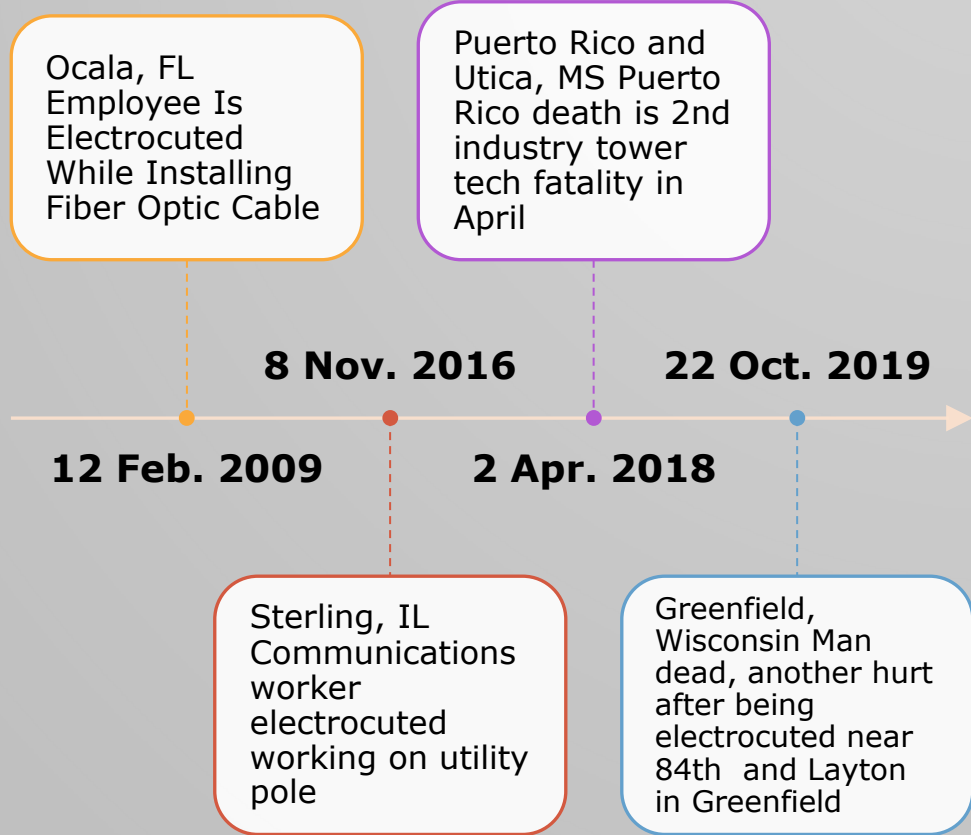
Data from NIOSH 98-131

NATE STAR Initiative Data

2017-2021

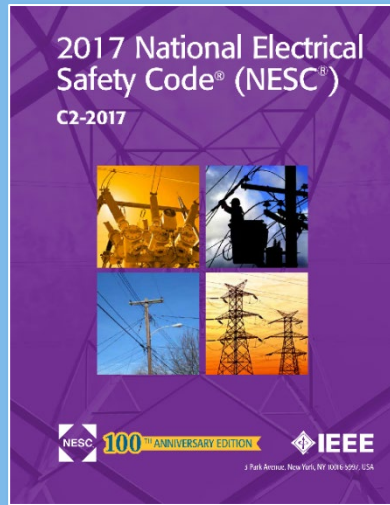
Year	Electrical Deficiencies
2017	62
2018	36
2019	55
2020	53
2021	54
Total Deficiencies	260

Why Be Concerned About Electrical Safety

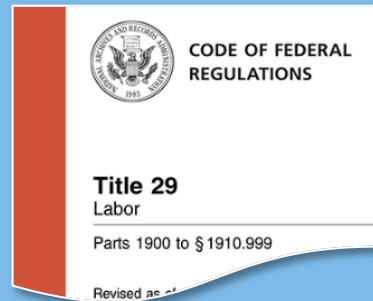


What Standards Apply?

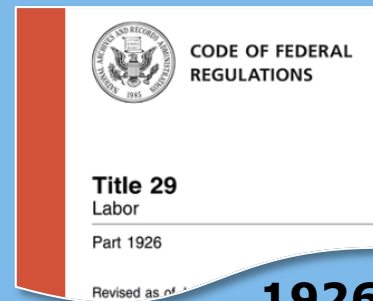
Electric Power



*How to
build AND work
on utility systems*



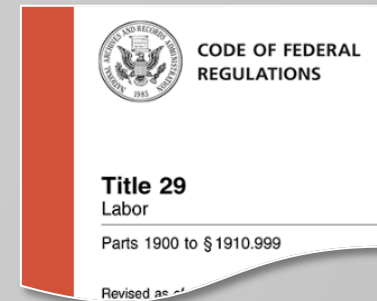
1910.269
*Operation &
Maintenance*



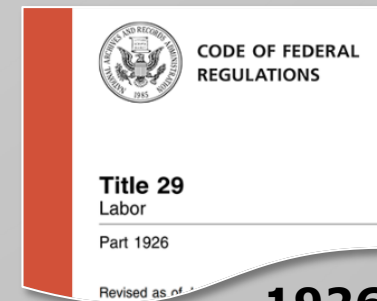
1926
Subpart V
Construction

**Awareness
of 1910.269
is Critical to
the Telecom
Worker**

**You
MUST know
which rules
you are
operating
under**



1910.268
Telecommunications



1926
Subpart M
Construction Fall Safety



SECTION 2

KEY POINTS

1. Importance of electrical safety.
2. Electrocution by age.
3. NATE STAR Initiative.
4. Why be concerned about electrical safety.
5. What standards apply.

SECTION 3

Basic Electrical Theory

Arc Flash

Static Electricity

Ohm's Law – Current (I), Voltage (V), and Resistance (R)

Electrical Circuit and Capacitor

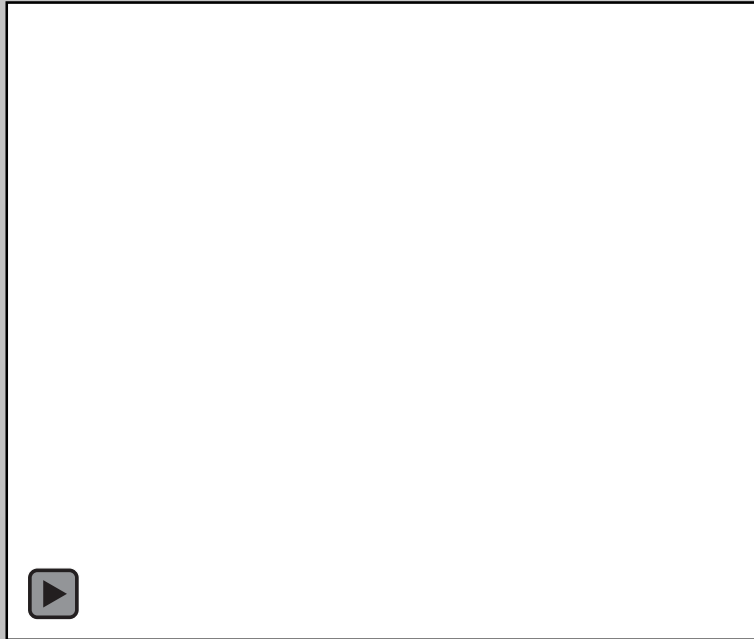
Alternating Current (AC)

Direct Current (DC) and Rectifier

Digital Multimeter (DMM)

480V Arc Flash

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



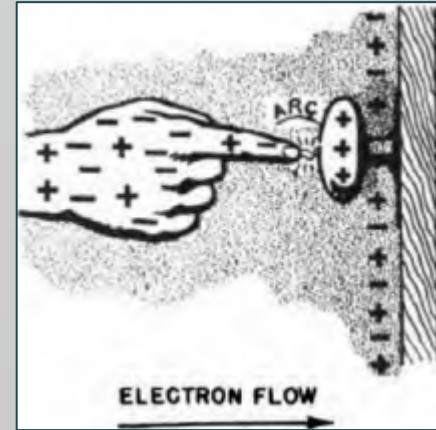
Indirect contact with power can also result in a serious injury or death. An electrical arc can jump or “flash” between an energized object and a ground in the vicinity of an individual causing a severe flash burn to the exposed skin and clothing. The corresponding arc may also cause a flow of current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

Static Electricity

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

Like charges repel each other.

Unlike charges attract each other.



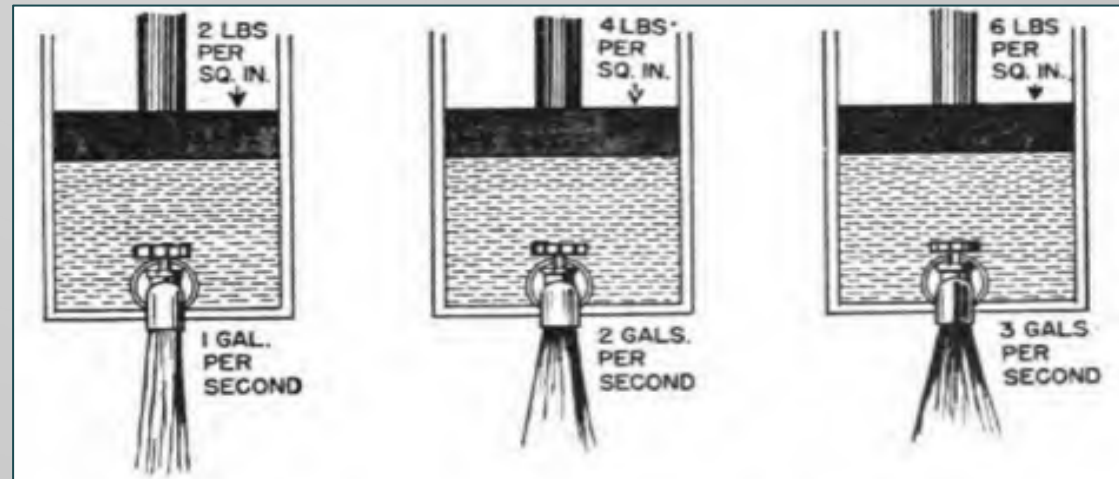
Lightning – is static electricity produced by the friction between air and water particles – a cloud picks up electrons and then discharges them to another cloud or back to earth.

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.**

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.

$$R=V/I$$

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

Ohm's Law – Key Takeaways

1. The strength of an electrical current/amperage, depends on the resistance of the circuit and the voltage applied to the circuit. Ohm's law will tell you how much current is flowing.
2. The resistance does not depend on either current or voltage. The character of the conducting path (wires and load) determine the resistance. In other words, you do not change resistance by changing current or voltage. Ohm's law will tell you how much resistance is contained in the circuit.
3. The electromotive force (voltage) of a circuit does not depend on either current or resistance. The voltage is determined by the electrical supply/source and Ohm's law will tell you how much voltage is required for a given current through a given resistance.

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

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.

Alternating Current (AC)

Alternating Current (AC) – An electric current that reverses its direction many times a second at regular intervals.

Another way to think about this is a two-way flow of electrons - a current which first flows in one direction and then reverses and flows in the opposite direction.

Direct Current (DC) and Rectifier

Direct Current (DC) – An electric current flowing in one direction only (most telecommunications systems are -48 DC). Power source is typically derived from batteries.

Rectifier – An electrical device that converts an alternating current (AC) into a direct one (DC) by allowing a current to flow through it in only one direction.

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.



Voltage Detectors



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.

SECTION 4

Overhead Transmission and Distribution

Establishing Approach Distances

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graph TD; A[Establishing Approach Distances] --> B[Spotter]; B --> C[General Safety];
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Spotter

General Safety

Trained Telecom Worker

1910.268 Trained Telecom worker

- WHEN OPERATING A MOBILE ELEVATED WORKING PLATFORM (MEWP) OR DIGGER/DERRICK, UTILIZE 29 CFR 1910.268, TABLE R-2 APPROACH DISTANCES TO EXPOSED ENERGIZED OVERHEAD POWER LINES AND PARTS FOR MAD CLEARANCE
- **Excluding California which follows GEO 95 Table 2940.2-4**
https://www.dir.ca.gov/Title8/2940_2.html

Minimum Approach Distances (MAD)

- Higher voltages can arc over several inches or even feet under some conditions, so greater distances need to be maintained when working in the vicinity of primary conductors.
- MAD can be found in 1910.268 Table R2.

Voltage Range (phase to phase, RMS)	Approach distance (inches)
300 V and less	Avoid Contact
Over 300V, not over 750V	12
Over 750V not over 2 kV	18
Over 2 kV, not over 15 kV	24
Over 15 kV, not over 37 kV	36
Over 37 kV, not over 87.5 kV	42
Over 87.5 kV, not over 121 kV	48
Over 121 kV, not over 140 kV	54

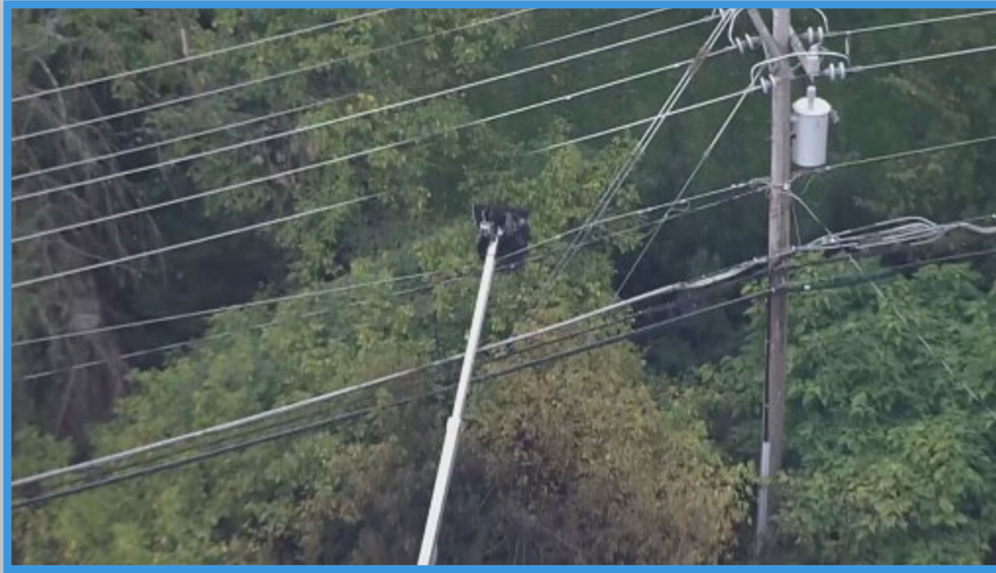
Note: An approach distance is the distance which you can approach the energized conductor with either your body or any object which you are in contact with. Secondary conductors which are used to supply power to a residence are below the 300v phase to phase voltage. For this reason, DO NOT come in contact with secondary voltage lines. Primary voltage which is normally above 300v phase to phase requires a minimum distance to approach. If primary voltage is present in your workspace, do not proceed and notify your supervisor immediately.

Measuring Clearance

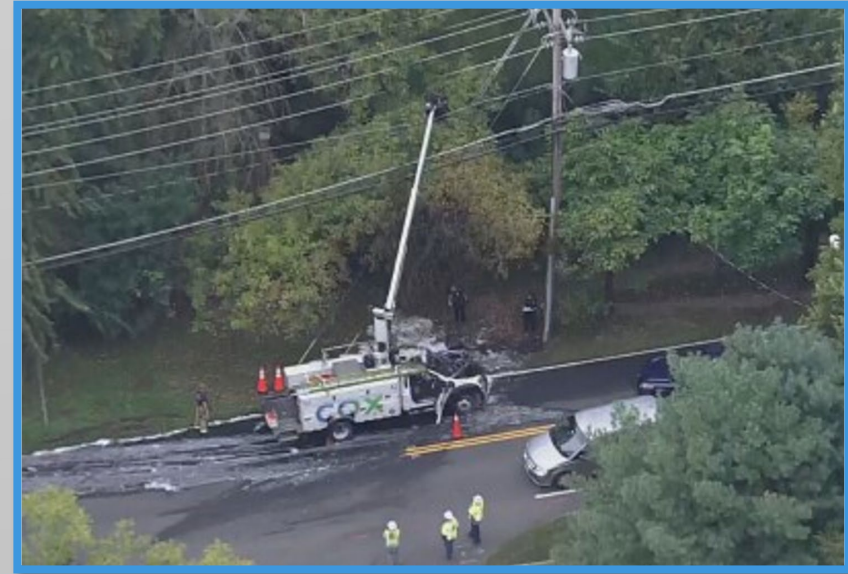
Worker sticking a pole to measure NESC spacing to assure that the 40" worker telecom space is maintained. "Workers can utilize an insulated (tested) measuring stick or laser range finder."



Failure to Maintain MAD



September 2022 fatality in Virginia



CRITICAL PROTECTION METHODS FOR OTHER EQUIPMENT

Voltage (nominal, kV, alternating current)	Minimum Clearance Distance (feet)
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000	(As established by the power line owner/operator or registered professional engineer who is a qualified person with respect to electrical transmission and distribution)

Spotter Definition

Spotter is a second pair of eyes and ears for drivers and equipment operators on the jobsite. They stand near the equipment or vehicle and feed information to the driver, including directions and things the driver is unable to see or hear by themselves.

Responsibilities of a Spotter

- Spotters must remain visible to truck and equipment operators when they are moving.
- Spotters must be aware of their surroundings and should never walk into the path of a vehicle, moving equipment, or a swinging load.
- Spotters need to scan the ground to become aware of any trip or fall hazards.
- Spotters should be limited to a single task, so they stay on task.

General Safety

- Direct communication with the operator of the equipment.
- Designated job is being a spotter.
- Maintain clear visual contact with whatever they want to avoid and the equipment.
- Maintain the minimum acceptable clearances from power lines per Table R-2 if trained. Best practices, maintain minimum distance of ten (10) feet from any power line operating at 50 kV or less.
- If the voltage of the power line is unknown, consult your company's HSE Policy Manual for guidance or contact the local electrical utility company.

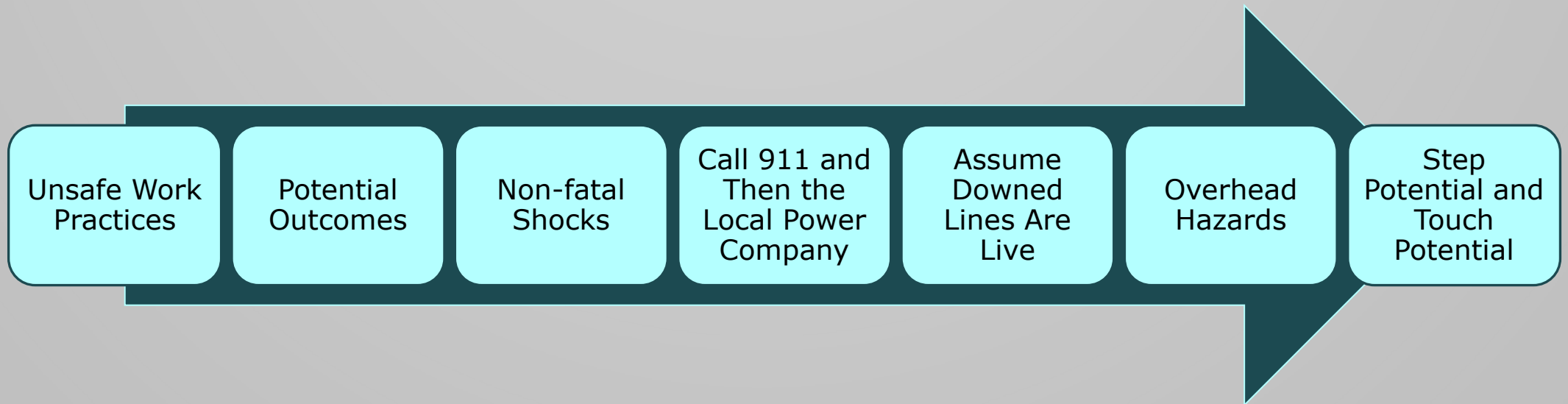
SECTION 4

KEY POINTS

1. Arms reach plus the MAD distance as established by the R2 tables.
2. The 40" NESC communication worker safety zone on the pole is not the MAD clearance requirement.
3. Role of the spotter is to have direct communication with the worker and ensure MAD is always maintained.
4. Establish the highest-level operating voltage on the pole for MAD requirements.
5. If the operating voltage of the facilities are not known, contact the local electric company.
6. Crane operators have different OSHA rules and increased MAD from energized facilities.

SECTION 5

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



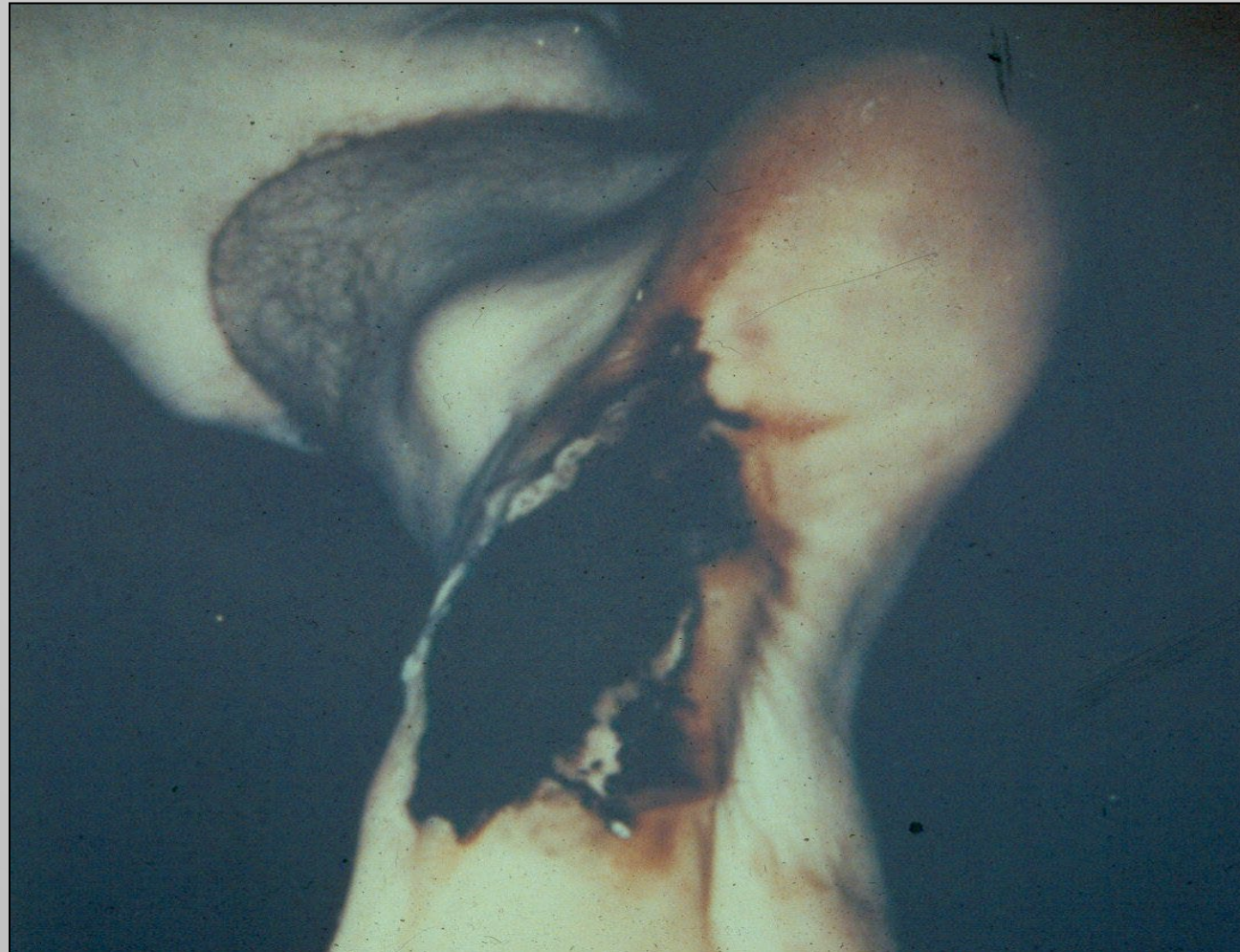
Unsafe Work Practices Can be Deadly!



Potential Outcomes

- What happens to you depends on how much, how long, and what part of your body the electricity goes through.
- People have survived shocks of several thousand volts.
- Others have been killed by voltages as low as 12 volts.
- Prevention means not becoming part of the electrical flow.

Non-fatal Shocks Can Result in Severe Burns



Call 911 and Then the Local Power Company



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 **35 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 move a downed power line.

If a vehicle contacts a **power line** or **utility pole**...

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 vehicle, downed lines, or anything that may be in contact with downed lines.
- Call **911**.

In the Event of Fire or Smoke

- Do not touch the ground and vehicle at the same time.
- Jump from the vehicle with your **feet together**.
- Shuffle away, avoid lifting your feet.

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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

Step Potential And Touch Potential

Step Potential is the voltage between the feet of a person standing near an energized grounded object.

Touch Potential is the voltage between any two points on a person's body – hand to hand, shoulder to back, elbow to hip, hand to foot, and so on.

Step Potential and Touch Potential – Excellent Explanation



Step Potential and Touch Potential

https://www.google.com/search?q=step+touch+potential+demonstration&rlz=1C1GCEA_enUS1012US1012&oq=&aqs=chrome.0.69i59i450l8.13090j0j7&sourceid=chrome&ie=UTF-8#fpstate=ive&vld=cid:cfc8982c,vid:E_0ug-mngLM



SECTION 5

KEY POINTS

1. Call 911.
2. Assume downed lines are live.
3. Step potential and touch potential.

SECTION 6

Qualified Person

Definition

Qualified
Employee/Person

- Telecom
- Electric Utility

Skills & Knowledge
Required for a Qualified
Person

- Electric Utility Industry
- Telecommunications

Qualified Person Definition

A qualified employee is defined as a worker who:

- Has been trained to avoid electrical hazards when working on or near exposed energized parts.
- Is familiar with the safety related work practices as required by OSHA standards.
- Is able to distinguish exposed live parts of electrical equipment.
- Is knowledgeable of the skills and techniques used to determine the nominal voltages of exposed parts and components.

What Makes a Person Qualified...Telecom

Qualified employee (qualified person)

Qualified employee

Any worker who by reason of his training and experience has demonstrated his ability to safely perform his duties.

1910.268(s)(33)

Qualified line-clearance tree trimmer

A tree worker who through related training and on-the-job experience is familiar with the special techniques and hazards involved in line clearance.

1910.268(s)(34)

It is the employer's responsibility that employees have additional training under 1910.268.

1910.268(C)

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)

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)

Skills & Knowledge Required for a Qualified Person (cont.)

Electric Utility Industry



- Understand the approach distances and determining factors for shock and arc boundaries.
- Understand decision making process necessary to be able to:
 - Perform job safety planning,
 - Identify electrical hazards,
 - Assess the associated risk,
 - Select the appropriate risk control methods, including PPE.

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

NFPA 70E 110.2(A)(1)

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.

SECTION 6

KEY POINTS

1. Qualified electrical worker must be qualified by the employer.
2. Has extensive competency-based training and skill on electrical hazards and work methods.
3. May be required to be licensed in certain jurisdictions having authority.
- 4. This training does not qualify!**

SECTION 7

Equipment

**Don't Become
Path the Ground**

**If You Make
Contact**

**Aerial
Equipment**

**Other
Equipment**

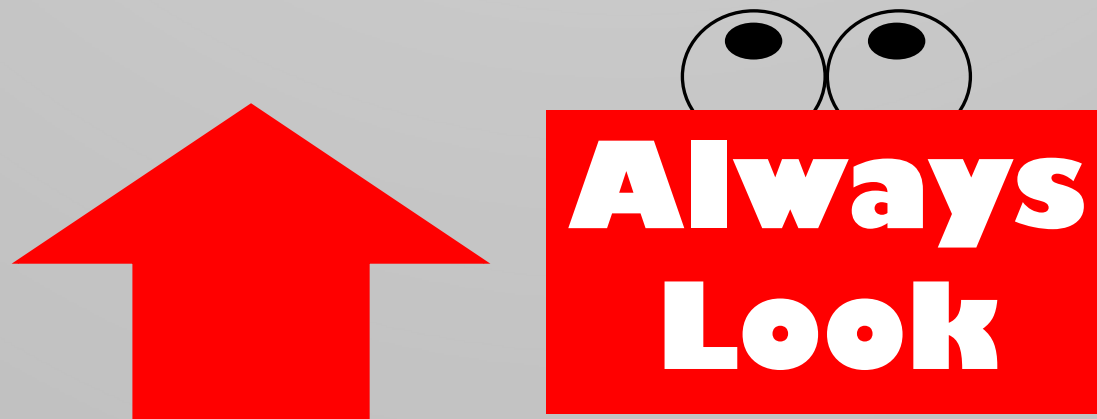
**Excavating
Equipment**

**Rigging
Systems**

Don't Become Path the Ground

When working near energized conductors:

- Always check above before you raise or lower any part of the equipment;
- Only the operator should be touching the equipment;
- Operate during daylight hours when possible or provide proper area lighting; and
- De-energize when possible.

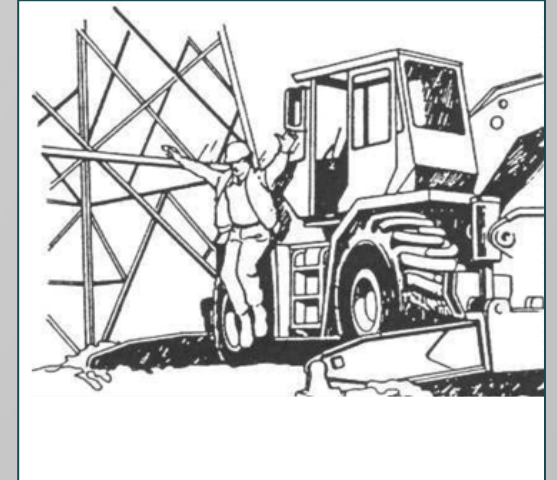


If You Make Contact

- 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”

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



- Ground personnel are over 8 times more likely to be killed.
- Operators are normally safe if they stay on the equipment.

Aerial Equipment

Path to ground



Miscellaneous



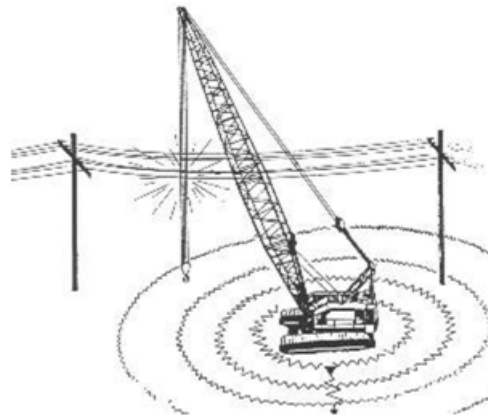
Pump Truck



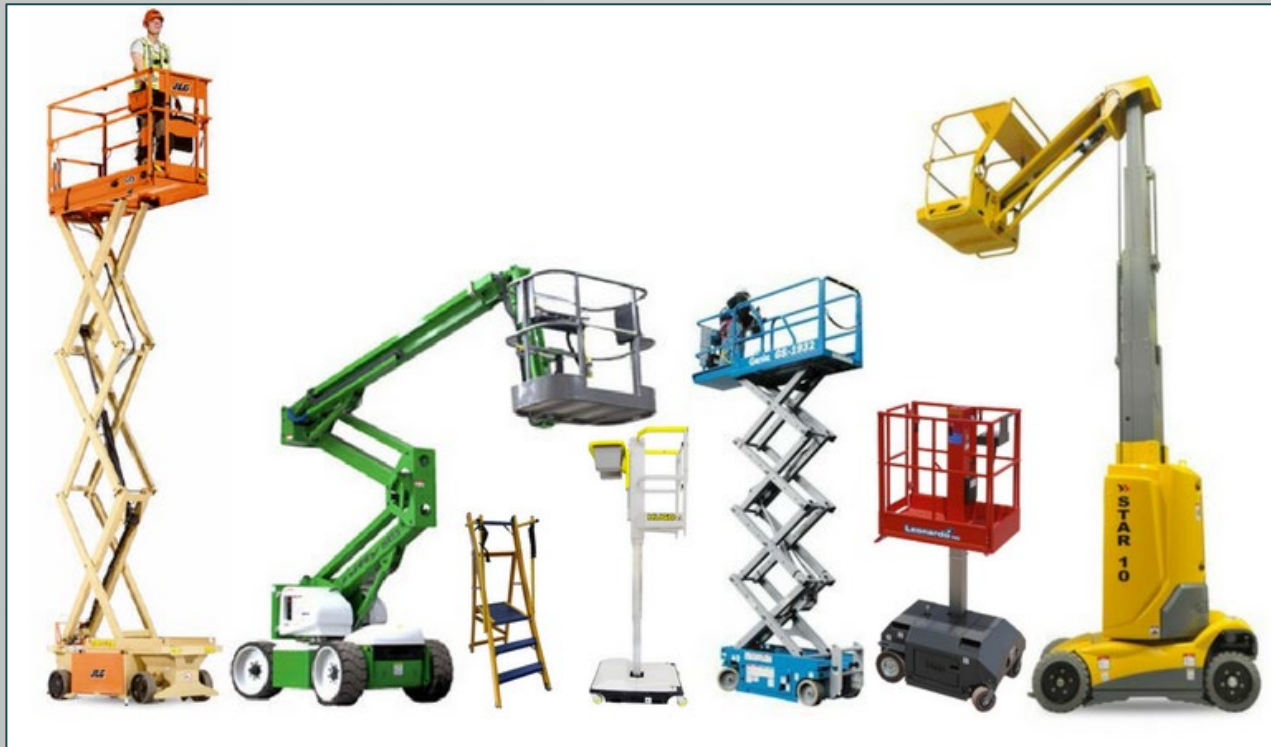
Crane

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



Mobile Elevated Working Platforms (MEWP) and Aerial Work Platform(AWP)



Excavating Equipment



Derrick



Rigging Systems



SECTION 7

KEY POINTS

1. Always maintain minimum approach distance - never assume it is de-energized.
2. Role of the spotter (also covered in section 4).
3. Equipment and the load can become energized if contact is made - never lean on or touch equipment that is near power lines.
4. Contact the local electric company to de-energize the line if MAD cannot be established and maintained.

SECTION 8

Lockout/Tagout

Definitions

Lockout/Tagout
Principles

Energy Control
Program and
Procedures

Materials and
Hardware

Training and
Communication

Group
Lockout/Tagout

Definitions

Affected employee is an employee whose job requires him or her to operate or use a machine or equipment on which servicing, or maintenance is being performed under lockout or tagout, or whose job requires him or her to work in an area in which such servicing or maintenance is being performed.

Authorized employee is an employee who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment

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.



Forms of Control of Hazardous Electrical Energy

- Simple Lockout/Tagout
- Complex Lockout/Tagout





Other Energy Sources

- Electrical
- 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.

Energy Control Procedure

Procedures

- Shall be developed, documented and utilized for the control of potentially hazardous energy
- Shall clearly and specifically outline techniques to be utilized to control hazardous energy



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.

Materials and Hardware – Locks and Tags

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

Training and Communication

Authorized employee

- Recognition of hazardous energy sources
- Type and magnitude of energy in workplace
- Methods and means for energy isolation and control

Affected employee

- Purpose and use of the energy control procedure

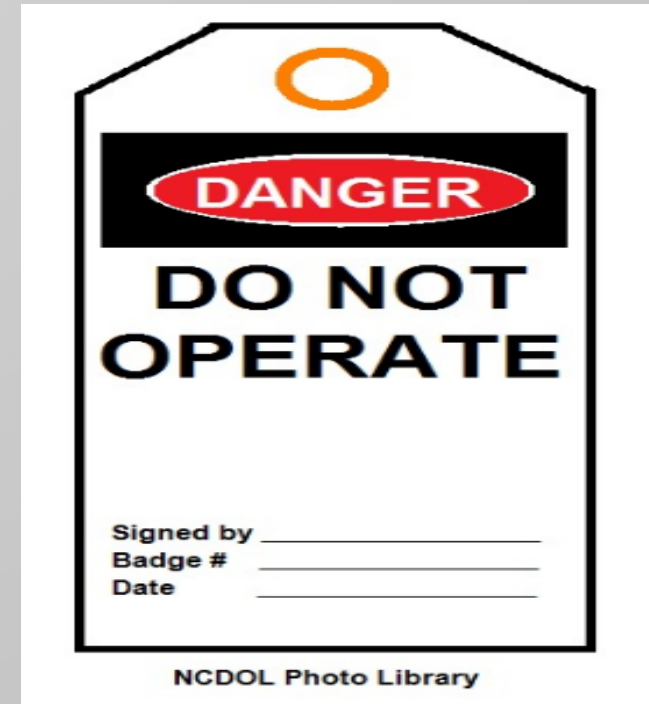
All other employees

- Procedures for energy control
- Prohibition of restarting or reenergizing equipment that is locked or tagged out

Training and Communication (continued)

Tagout system limitations

- Warning devices only; do not provide physical restraint,
- Must not be removed/bypassed/ignored,
- Must be legible and understandable,
- Must withstand environmental conditions,
- May evoke false sense of security,
- Must be securely attached.



Energy Isolation

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



Notification of Employees

- **Affected employees** shall be notified by the employer or authorized employee of the application and removal of LOTO devices.
- Notification given **before** controls are applied, and **after** they are removed from the machine or equipment.



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

LOTO Device Removal

- Each LOTO device shall be removed from each energy isolating device by the employee who applied the device.
- **Exception:** When authorized employee who applied the LOTO device is not available, device may be removed under the direction of the employer.

Employer removal of LOTO device

- Specific procedure shall include:
 - Verification by employer that authorized employee who applied device is not at the facility,
 - Making all reasonable efforts to contact authorized employee to inform them that LOTO device has been removed, **and**
 - Ensuring that authorized employee has this knowledge before they resume work at facility.

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

Group Lockout/Tagout

When servicing and/or maintenance is performed by a group or multiple parties, they shall utilize a procedure which affords employee protection equivalent to a personal LOTO device.

- Primary responsibility is vested in an authorized employee;
- Authorized employee must ascertain exposure status of group members;
- If more than one crew is involved, a coordinator shall be designated; and
- Each authorized employee shall use a personal LOTO device and remove device when they stop working on machine/equipment.

SECTION 8

KEY POINTS

1. Employers must have A LOTO program and procedures.
2. LOTO procedures are to protect authorized and affected workers.
3. Only the person who applied the LOTO tag is authorized to remove the lock/tag.
4. Only in special circumstances can a LOTO tag and lock be removed by another.

SECTION 9

Hand Tools and Portable Generators

Hand
Tools

Extension
Cords

Related
Work
Activities

Hazardous
Conditions
and
Unsafe
Acts

For Your
Safety

Portable
Generators

Electric
Shock

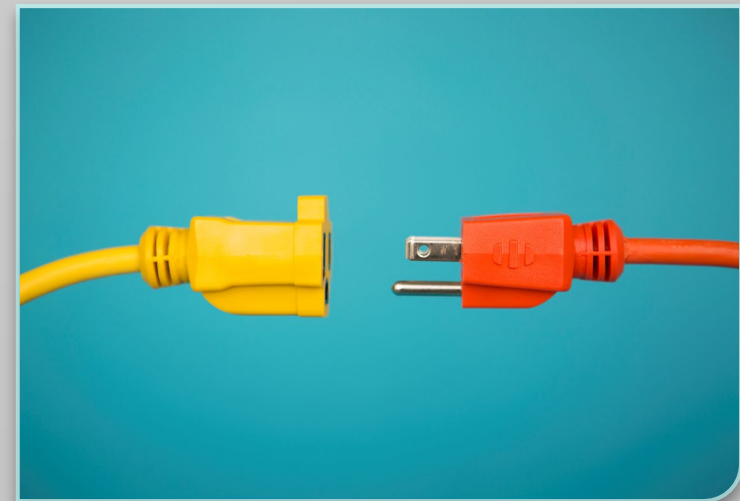


Hand Tools

- Selecting the correct tool for the job.
- Inspecting the tools for damage that could result in injury.
- Ensuring that tools are clean and free of dirt/oil/grime.
- Following proper protocol when using the tools.

Extension Cords

- Right gauge and use
- Using with Ground-Fault Circuit Interrupters (GFCI)



Electricity



Related Work Activities

- Using power tools.
- Digging, excavating and boring.
- Exposure to overhead power lines.
- Falling branches.
- Utility line tree trimming services.

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.

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.

Path of Least Resistance

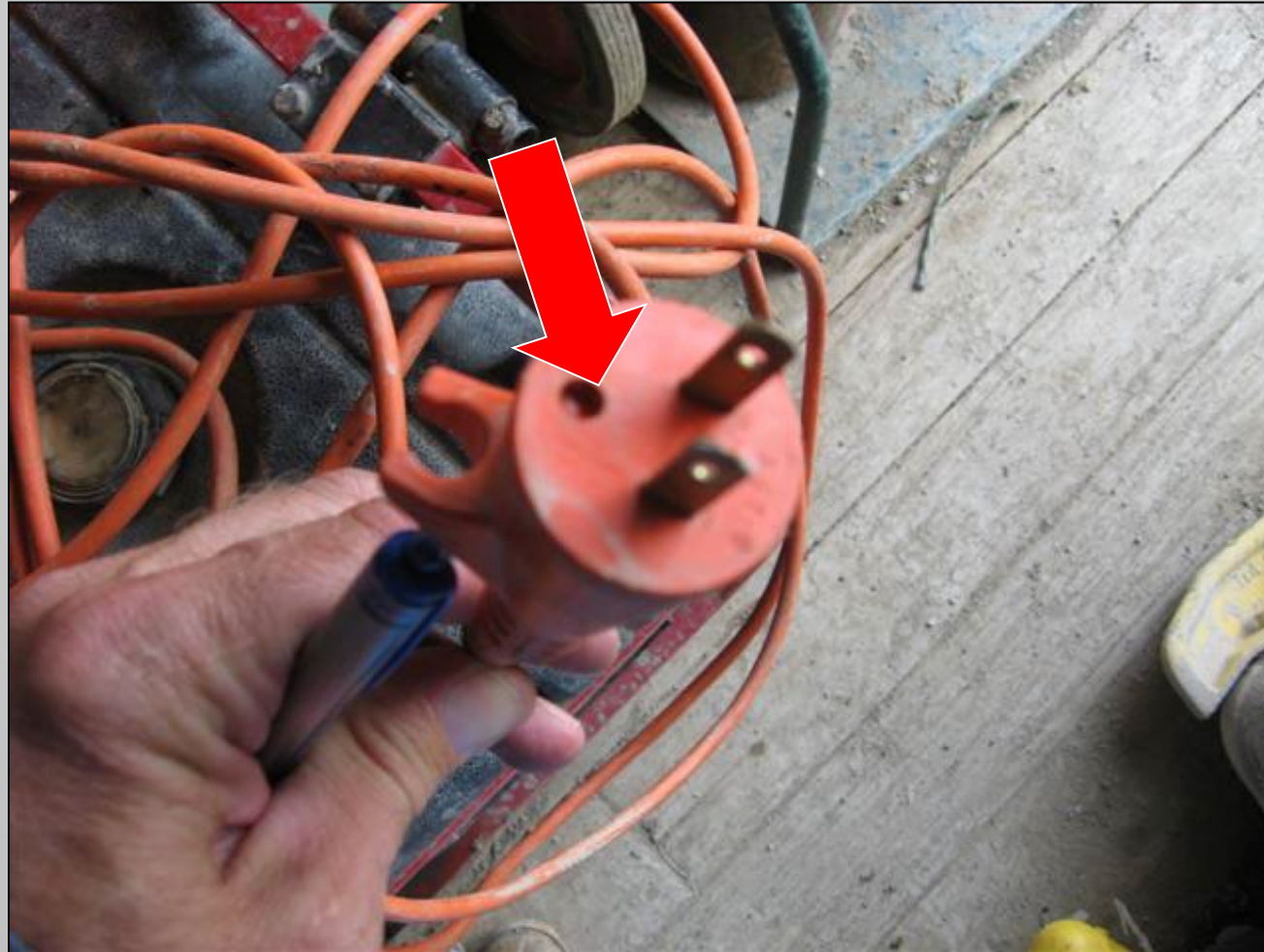
- Electricity always follows through the path of least resistance.
- Creating an easy path for current that doesn't include your body.
- If your body becomes part of the path, electricity will flow through it.
- If that path is through vital organs like your heart and lungs you can die.

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

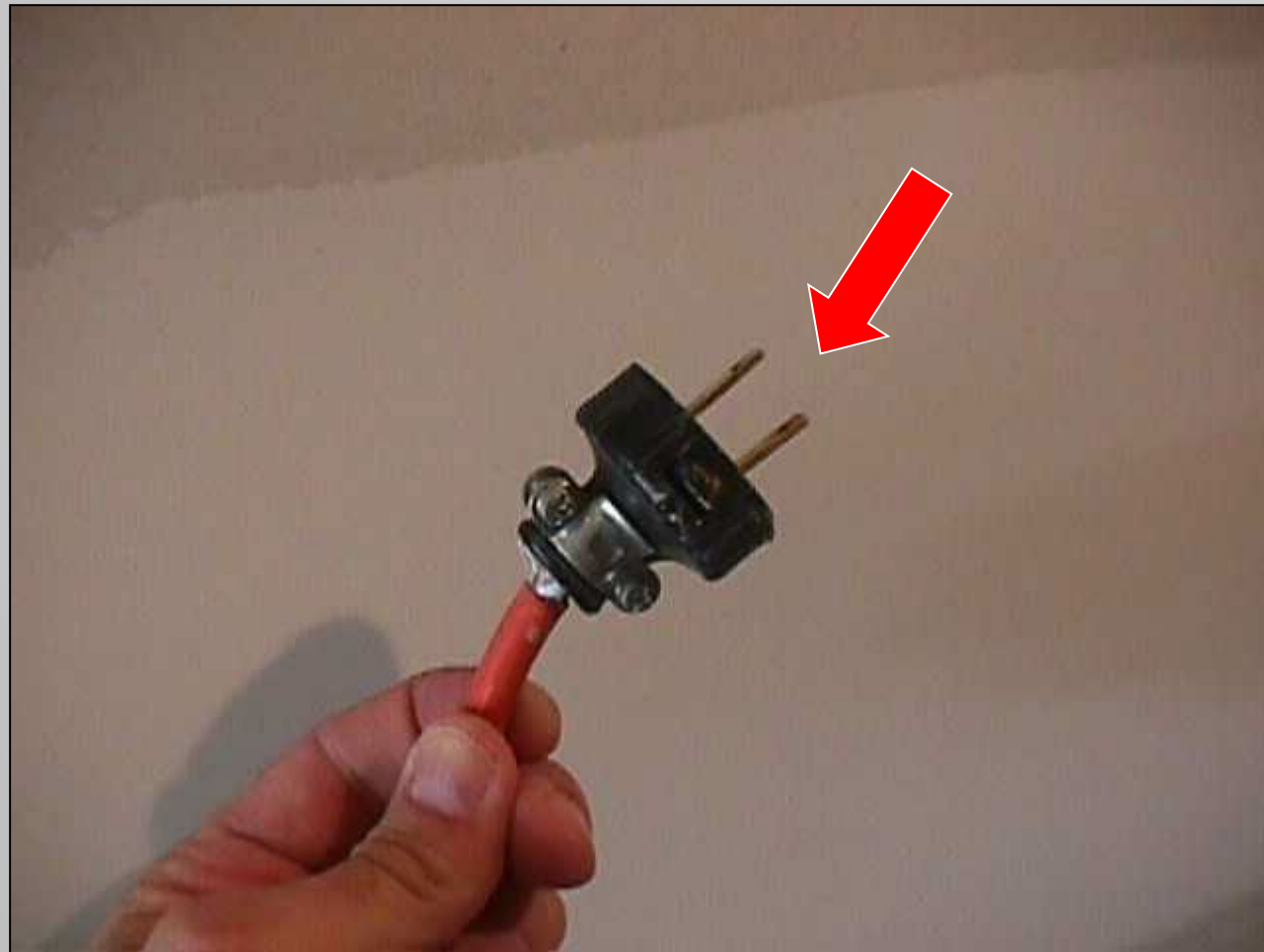
For Your Safety

- Electrical power tools should have a true ground or be double insulated.
- Never cut off the third ground prong or use equipment with one of the three prongs broken.
- If you feel a tingling sensation while you are using a tool, stop using the tool immediately. **Take it out of service!**

Danger! Missing Ground Prong



Do Not Use!



No third prong here either, due to an unauthorized repair.

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.

Electrical Shock

Helping an Electrical Shock Victim:

- Call for immediate help.
- Disconnect or de-energize the circuit.
- **Do not** try to remove the victim from the current source!
- Touching the victim could cause you to be shocked as well.

SECTION 9

KEY POINTS

1. Path of least resistance – power tools.
2. Extension and temporary power cords must be inspected prior to use.
3. Damaged cords and plugs must be removed from service until repaired by a qualified person or replaced.
4. GFCI's are required for construction use and protect workers from electrical shock.
5. Portable generator safety.

SECTION 10

Installation of Electrical Telecom Equipment

Hybrid Cable Assembly

Base Station Equipment

Remote Radio Heads

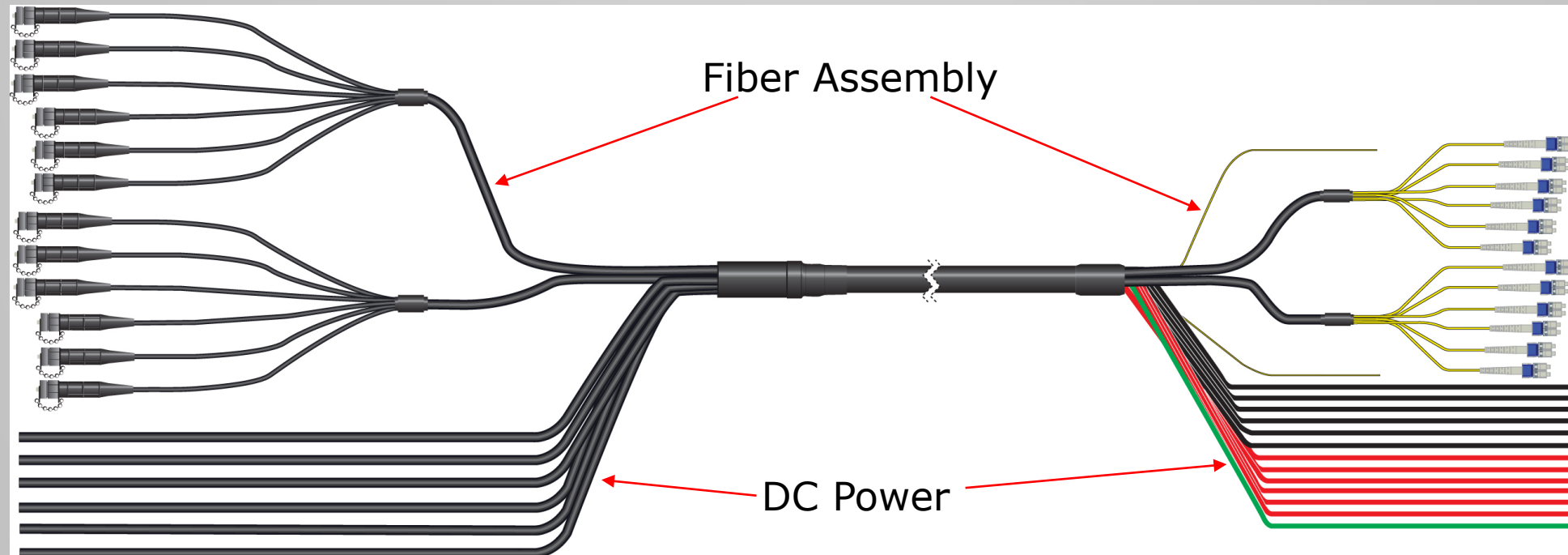
Termination and
Installation

Permanent Backup
Generators

Test Before You Touch

Stray Voltage Safety Alert

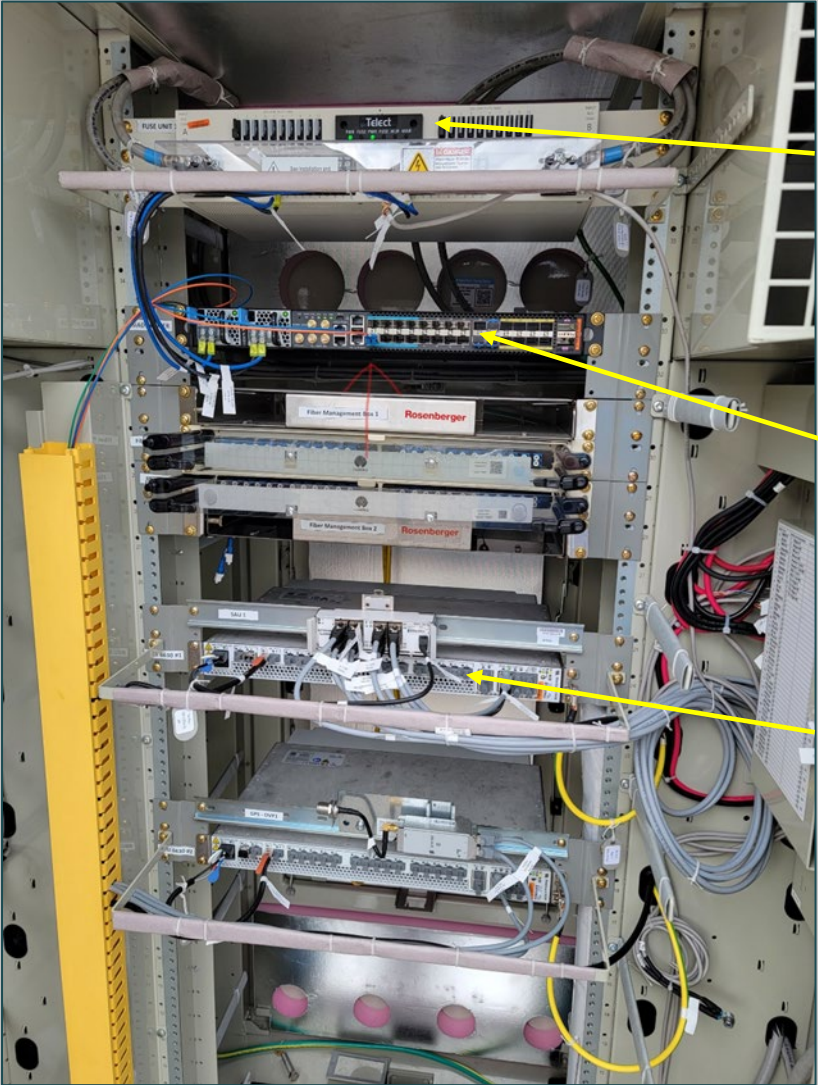
Hybrid Cable Assemblies



- 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

Base Station Equipment



PDU or DC
Power
Distribution Unit

Fiber Patch Panel

Customer Radio
Equipment

24 VDC Batteries



ALWAYS CONFIRM YOUR CONDUCTOR SIZE IN YOUR
DESIGN DOCUMENTS

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

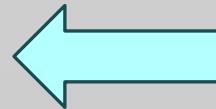
- This can be AC or DC depending on the equipment
- Most are also fiber fed but can be copper



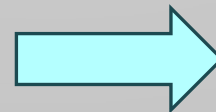
Termination and Installation



A technician terminates DC power in a Raycap Inverter



An electrician installs a backup battery system for highway lighting



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



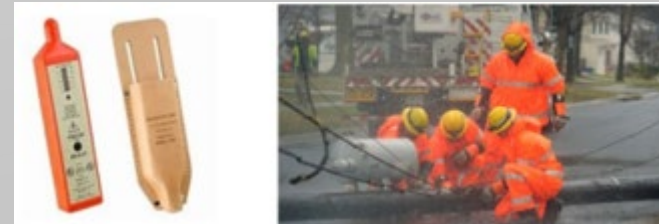
Test Before You Touch

Always test using approved tools, equipment and/or processes, before touching equipment or conductors.



How to Test Before You Touch

1. Ensure all participants are qualified for the job
2. Identify potential hazards
3. Wear correct PPE and use the proper tools
4. De-energize the circuit
5. Lockout/Tagout
6. Verify the testing device
7. Test the circuit



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.

Safety Alert (continued)

- 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.
- 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.

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.

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

Call Before You Dig

www.commongroundalliance.com

THE 811 PROCESS **811** FOR CONTRACTORS

1 NOTIFY
Notify your local one-call center by calling 811 or making an online request 2-3 days before work begins. [Click here](#) for information about your local one-call center and online service availability. The one-call center will transmit information to affected utility operators.

2 WAIT
Wait 2-3 days (varies by state, please [click here](#) for state law information) for affected utility operators to respond to your request. On average, between 7-8 utility operators are notified for each request.

3 CONFIRM
Confirm that all affected utility operators have responded to your request by comparing the marks to the list of utilities the one-call center notified. State laws vary on the process for confirmation; please check with your local one-call center for more information. If you see clear evidence of a utility, such as an above-ground marker, manhole cover or utility box, but no marks, please call 811 so that utility can be notified.

4 RESPECT
Respect the marks. The marks provided by the affected utility operators are your guide for the duration of your project. If you are unable to maintain the marks during your project, or the project will continue past your request's expiration date (varies by state), please call 811 to ask for a re-mark.

5 DIG CAREFULLY
State laws generally prohibit the use of mechanized equipment within 18-24 inches of a marked utility, which is called the "tolerance zone" ([click here](#) for information from your state). If you must dig near the marks, hand dig or use vacuum excavation to expose the facility. After exposing the facility, avoid using mechanized equipment within the same tolerance zone.

For projects that include new construction site prep, utility installation and repair and landscaping, among others.

Utility Marking Colors



WHITE

Proposed Excavation

PINK

Temporary Survey Marking

RED

Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW

Gas, Oil, Steam, Petroleum, Gaseous, and Hazardous Materials

ORANGE

Communications, Alarm or Signal Lines, Cables or Conduit, and Traffic Loops

BLUE

Potable Water

PURPLE

Reclaimed Water, Irrigation and Slurry Lines

GREEN

Sanitary and Storm Sewer Lines

Locating Equipment



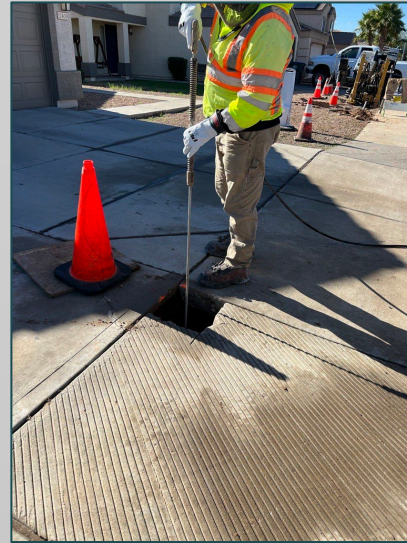
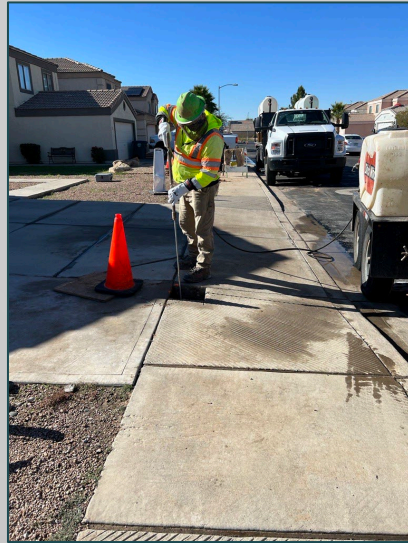
Warning Tape



- Here a trenching crew installs warning tape to identify where buried conductors are located.
- Warning tape is placed per the construction drawings usually between 16 and 24 inches above the cables which are being marked.
- Provides another layer of identification outside locate services to help prevent destruction of underground services.

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.



SECTION 11

KEY POINTS

1. Call 811 before you dig.
2. Jurisdictional, company, private property locate requirements.
3. Utility marking colors and tolerance zone.
4. Locating equipment.
5. Verify before you dig.

SECTION 12

Grounding and Bonding

Grounding

Bonding

Dalziel's Table

Earth Grounding for Worker Protection

Grounding for Equipment

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.**

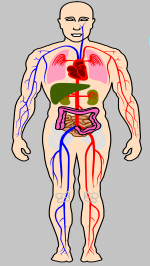


Bonding

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.

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

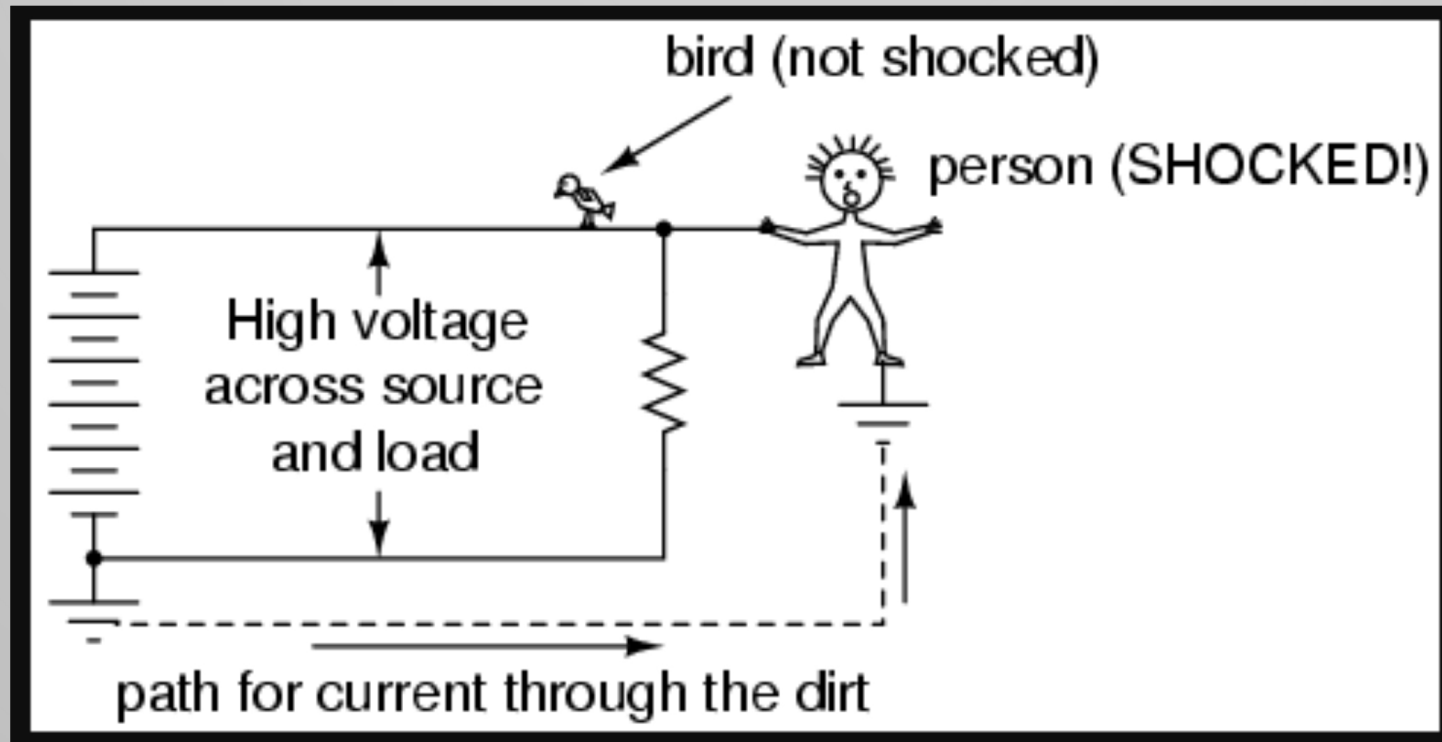
Earth Grounding For Worker Protection

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

1. Unsafe equipment or installation;
2. Unsafe environment;
3. Unsafe work practices.

Grounding

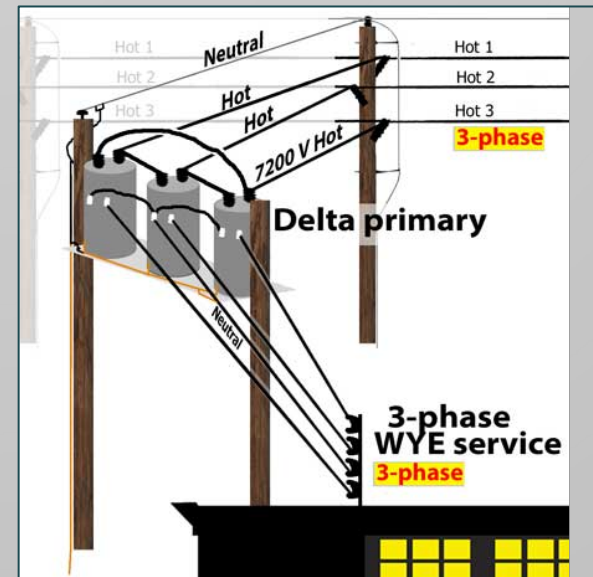
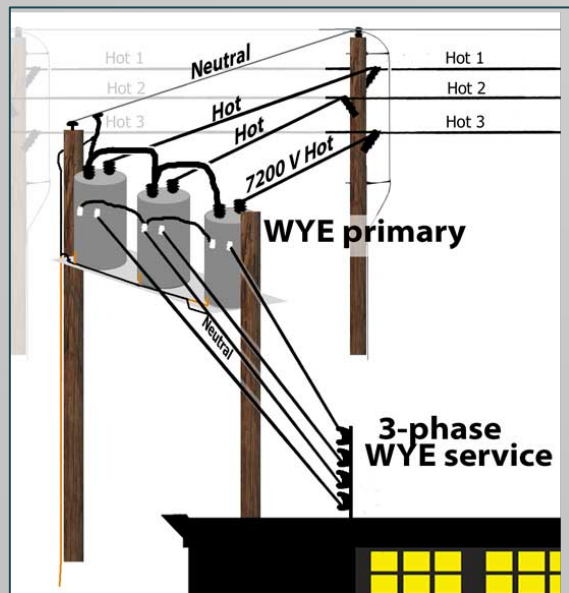
Electrically connecting communication hardware to an effective electrical ground.



Grounding for Equipment

Two Systems:

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



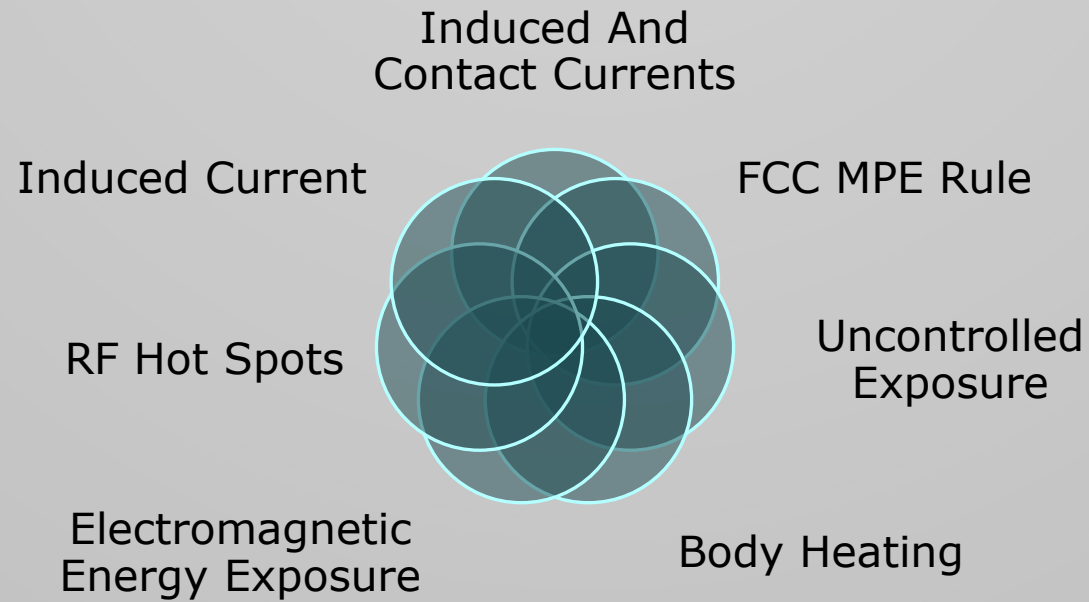
SECTION 12

KEY POINTS

1. Definition of Grounding.
2. Definition of Bonding.
3. Verification of Grounding.
4. Grounding for Equipment:
 - a. Wye
 - b. Delta

SECTION 13

Induced Current

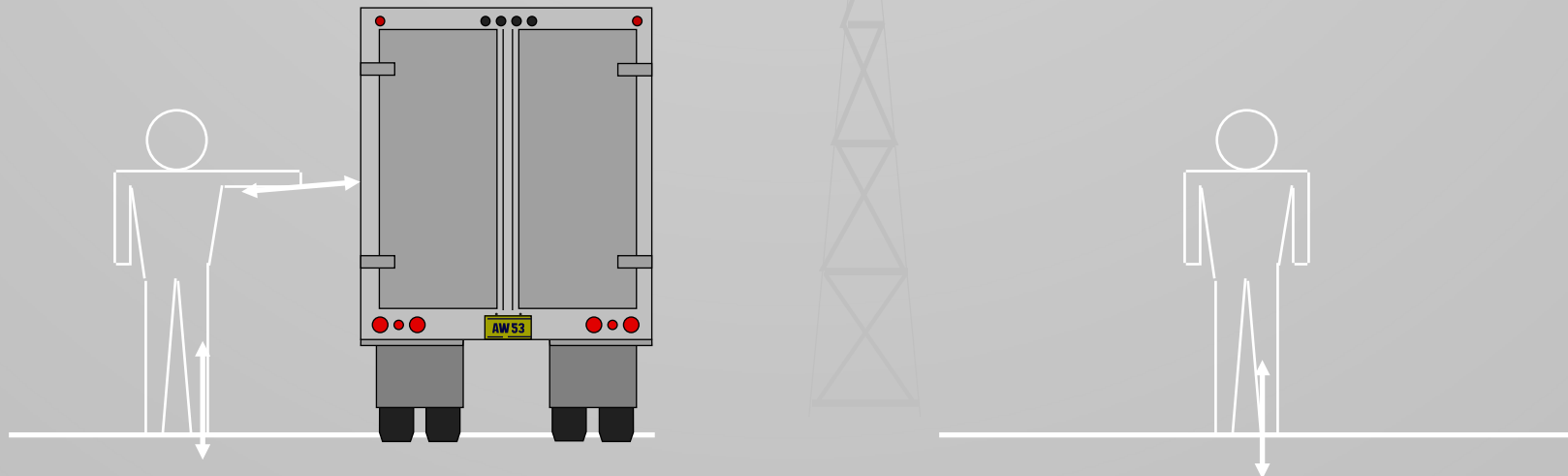


Induced and Contact Currents

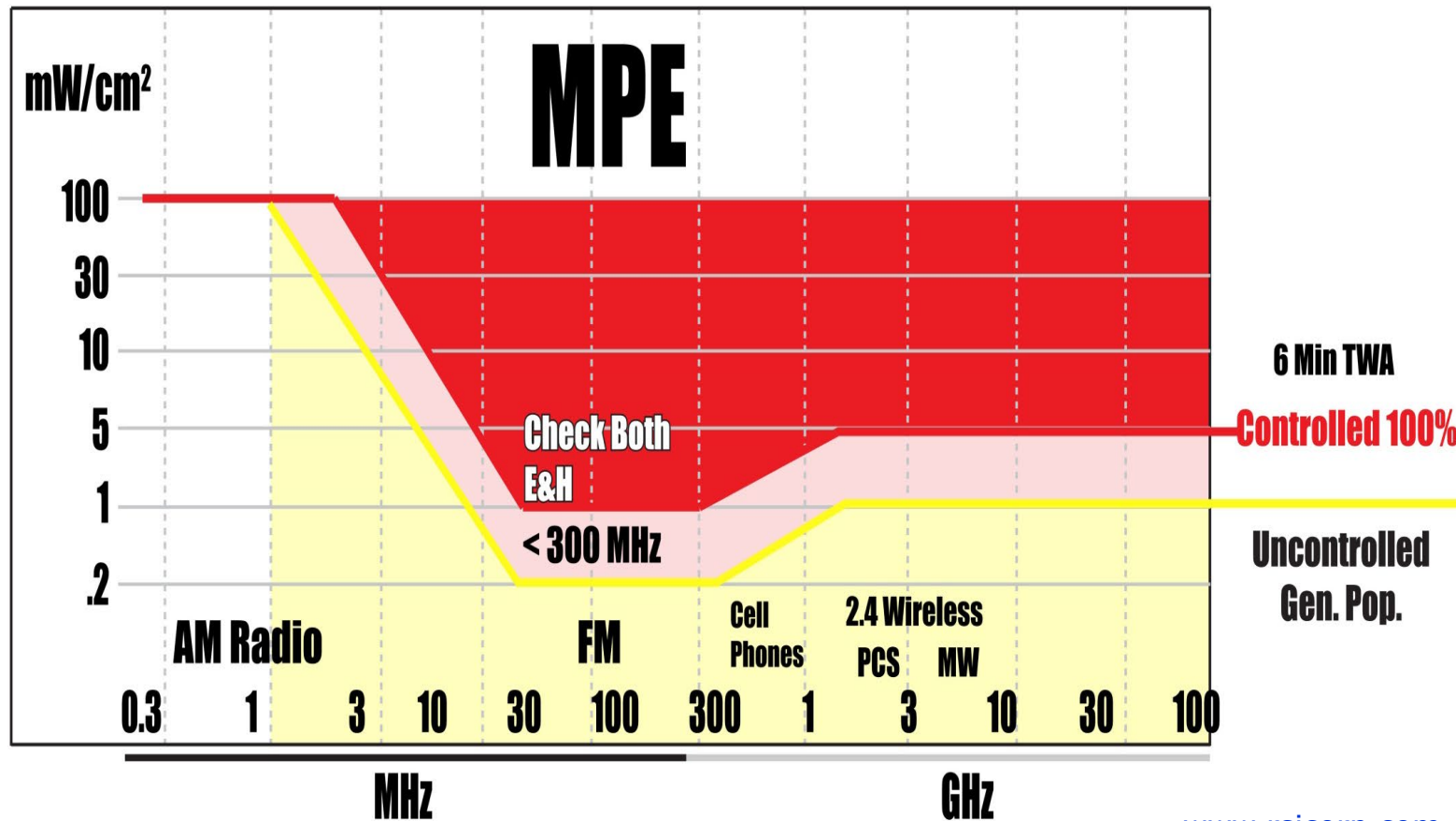
Two Scenarios:

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

- RF induces voltage flow in person.
- Current flows to ground.



FCC Maximum Permissible Exposure (MPE) Rule



General Population/Uncontrolled Exposure Level - Not Trained

Applies to situations in which the public may be exposed or persons who are exposed as a part of their employment (workers).

They may have not been made fully aware of the potential for exposure or cannot exercise control over their exposure.

Body Heating

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



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.

RF Hot Spots

When working at a site, attention should be given to the possibility that conductive objects may distort RF fields in their vicinity even though they are not actively energized by a transmitter and may produce RF hot spots exceeding the MPE's and may have possible high current.

Many sources of RF fields may exist in the form of **metallic structures** found near active RF sources that can **reflect and scatter fields** into areas not anticipated.

Induced Current

Has a strong potential to induce electrical current in nearby conductive or metal objects.



NOTE: The tower could also be a mile or more from your site.

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.



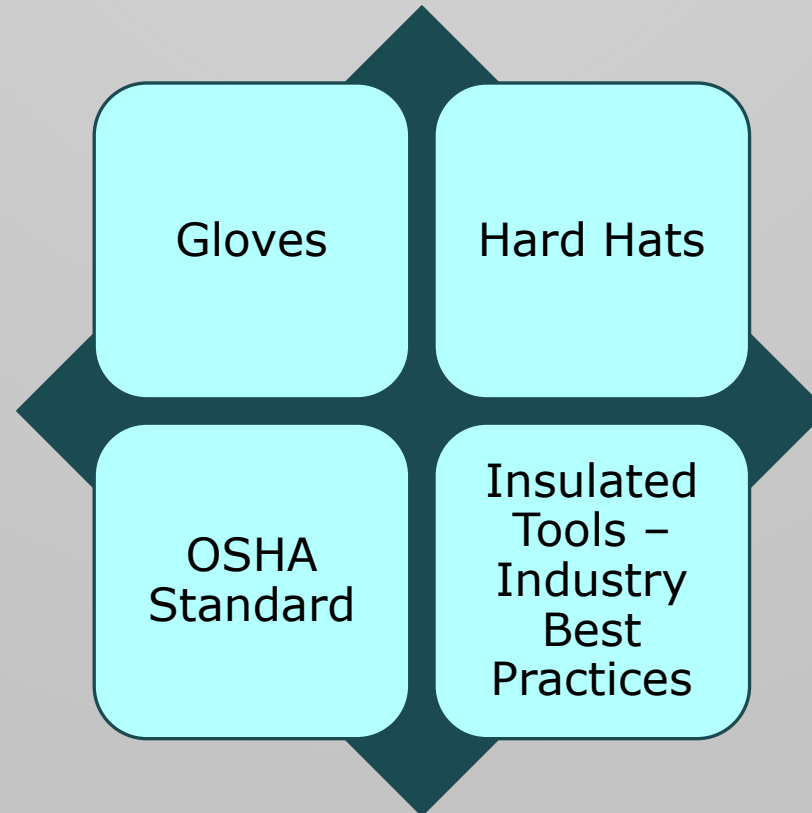
SECTION 13

KEY POINTS

1. Definition of induced current.
2. Definition of contact current.
3. FCC Maximum Permissible Exposure (MPE) rule.
4. Induced current from an AM tower.

Section 14

Personal Protective Equipment (PPE)



Gloves

Leather gloves for grounding and less than 50V work.



* Insulated gloves are for qualified workers and requires special training and testing.



Classes of Hard Hats – Class E



Class E (Electrical)

- Electrical work.
- Protect against falling objects.
- Protect against high-voltage shock/burns (proof-tested at 20,000 volts).



OSHA Standard

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.

Insulated Tools – Industry Best Practice



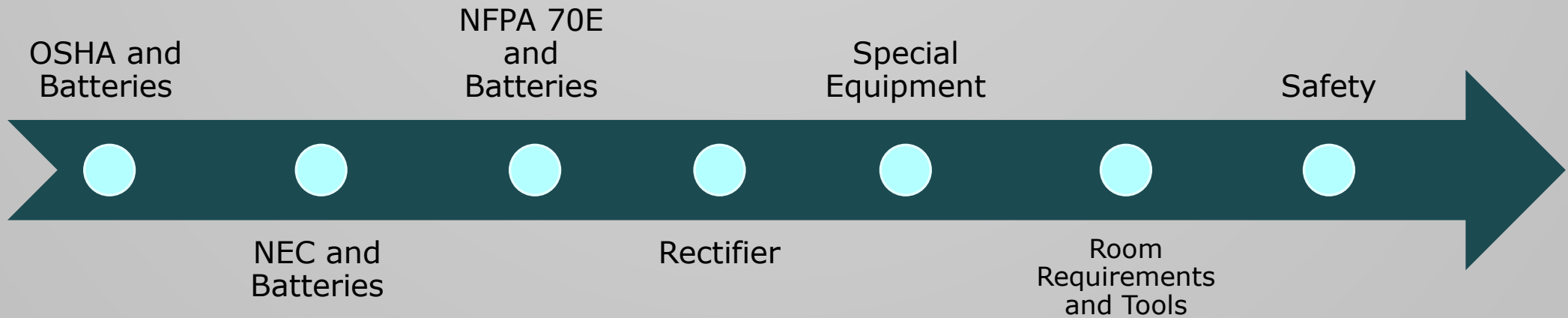
SECTION 14

KEY POINTS

1. PPE is different for qualified telecom workers.
2. Industry best practice – insulated tools.

SECTION 15

Battery Safety



OSHA[®] and Batteries

29CFR Part 1910 (selected parts)

- 1910.120 – Spill Kits
 - Open to interpretation (probably required for flooded batteries), and not Required for VRLA.
- 1910.133(a)(1) – Eye and Face Protection
 - 1910.268(b)(2)(i) – Goggles or face shield for flooded spill cleanup, H₂O adds, and bulb hydrometer specific gravity readings.
 - Safety glasses when making electrical connections/taking electrical readings.
- 1910.136(a) – Foot Protection (Safety-toed Shoes) with Heavy Batteries.
- 1910.268(b)(2)(i) - Acid resistant gloves and apron.

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)



The NEC and Batteries

NFPA 70 (National Electrical Code)

- NEC does not cover electric utilities and telecom utilities inside their owned 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.

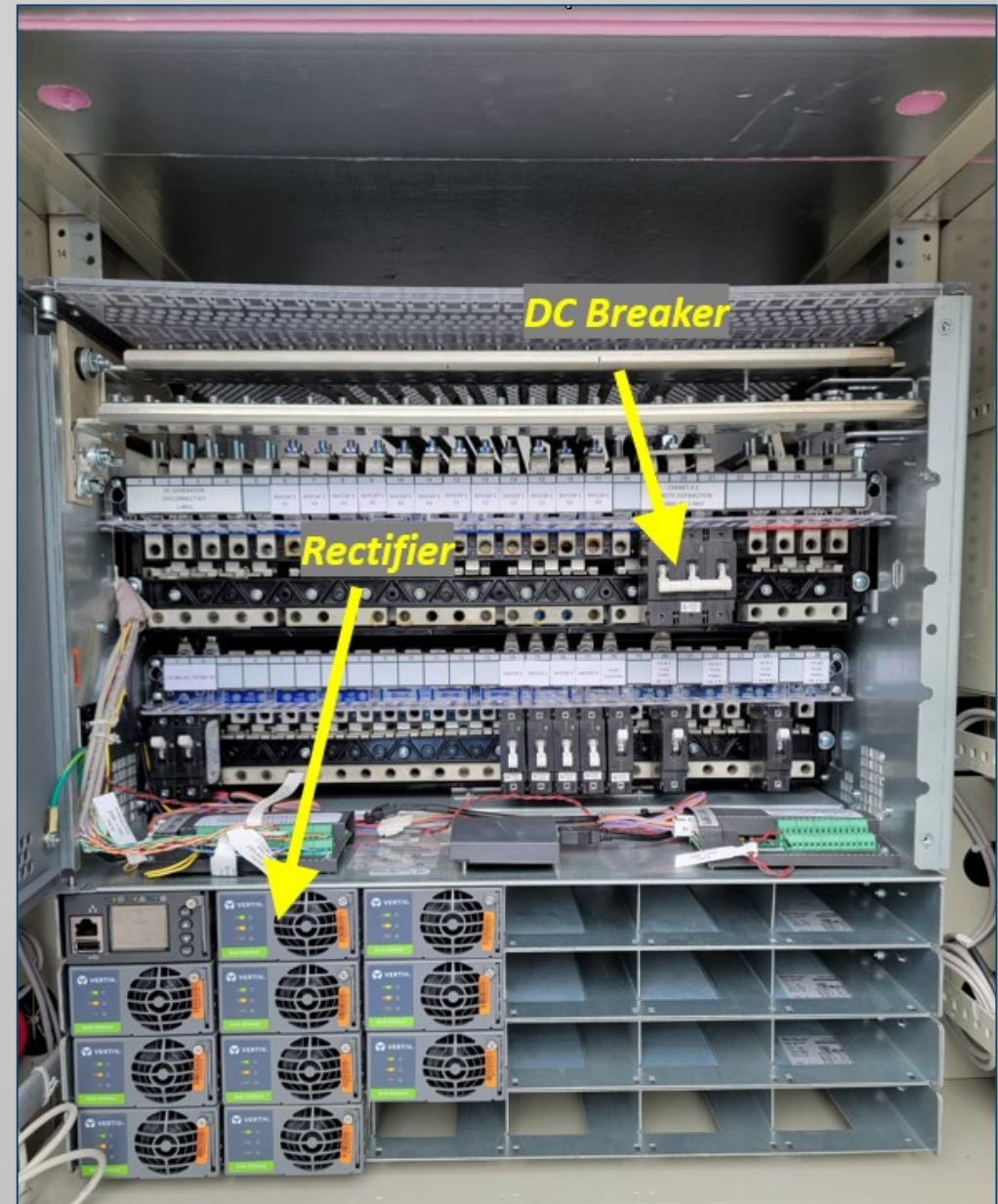


- Arc Flash generally not required for nominal 50V or less.
- General Telecom Equipment is typically -48V DC.

Rectifier

An electrical device that converts an alternating current (AC) into a direct one (DC) by allowing a current to flow through it in only one direction.

DC Breaker cuts off the power to the DC powered equipment (upstream).



Special Equipment – Batteries

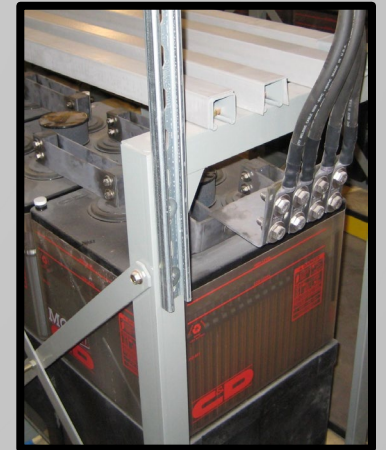
- Applies to stationary batteries exceeding 50 volts.
- Specific safety procedures:
 - Battery risk assessment;
 - Abnormal battery conditions;
 - Electrolyte hazards; and
 - Additional tools /equipment requirements.



Room Requirements and Tools

Room Requirements

- Restricted to authorized personnel
- Illumination adequate to perform work
- Installation requirements in NEC:
 - Account for seismic activity
 - Spill containment systems
 - Ventilation
 - Flame arresters



Voltage insulated; non-sparking tools may be required.



Typical Battery Safety PPE – Acid/Electrical

Wear appropriate PPE while performing Battery Maintenance.

- Arc Rated PPE
 - Aramid cloth is more acid resistant (Nomex, Kermel)
- Arc-rated face shield and goggles
- Chemical resistant aprons
- Rubber insulating gloves
- Protective overshoes



SECTION 15

KEY POINTS

1. OSHA standards when working with batteries.
2. NFPA 70E standards when working with batteries.
3. Safety precautions for rooms storing batteries.

SECTION 16

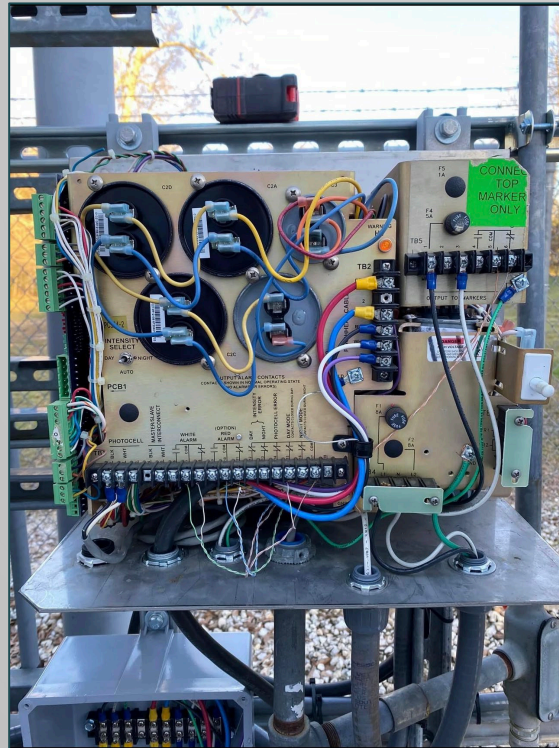
Tower Lighting and Capacitors

What is a Capacitor

Low, Medium, and High Intensity Lighting

FAA Tower Lighting Standards

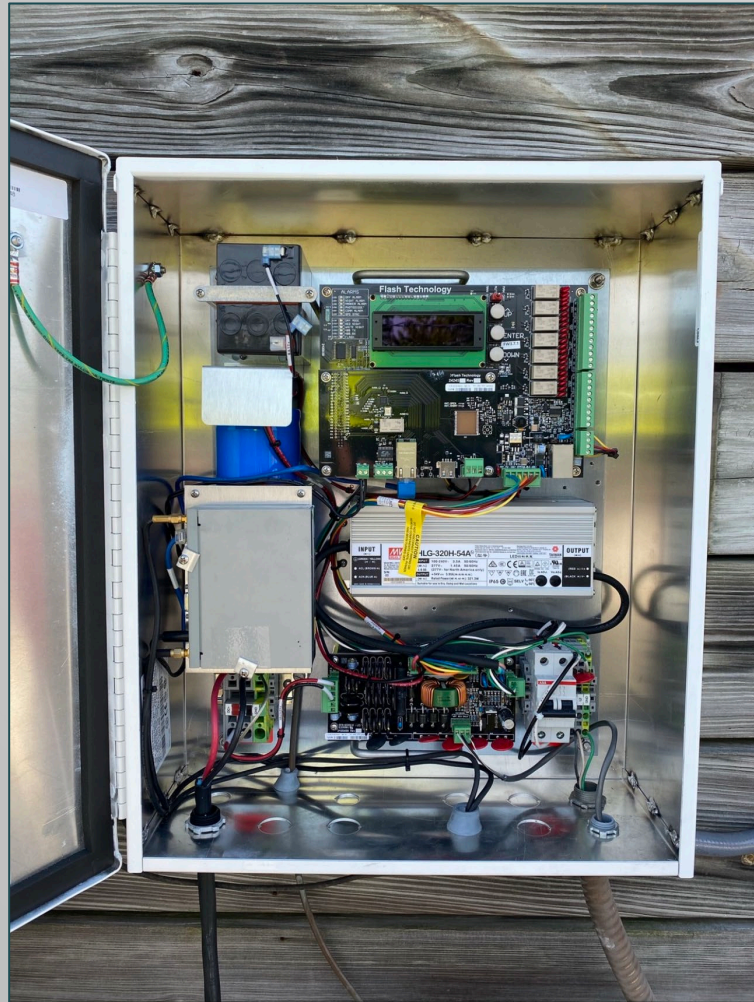
What Is A Capacitor



- A capacitor stores electrical energy in an electric field.
- A battery converts chemical energy into electrical charge.
- Typically used in medium intensity systems.

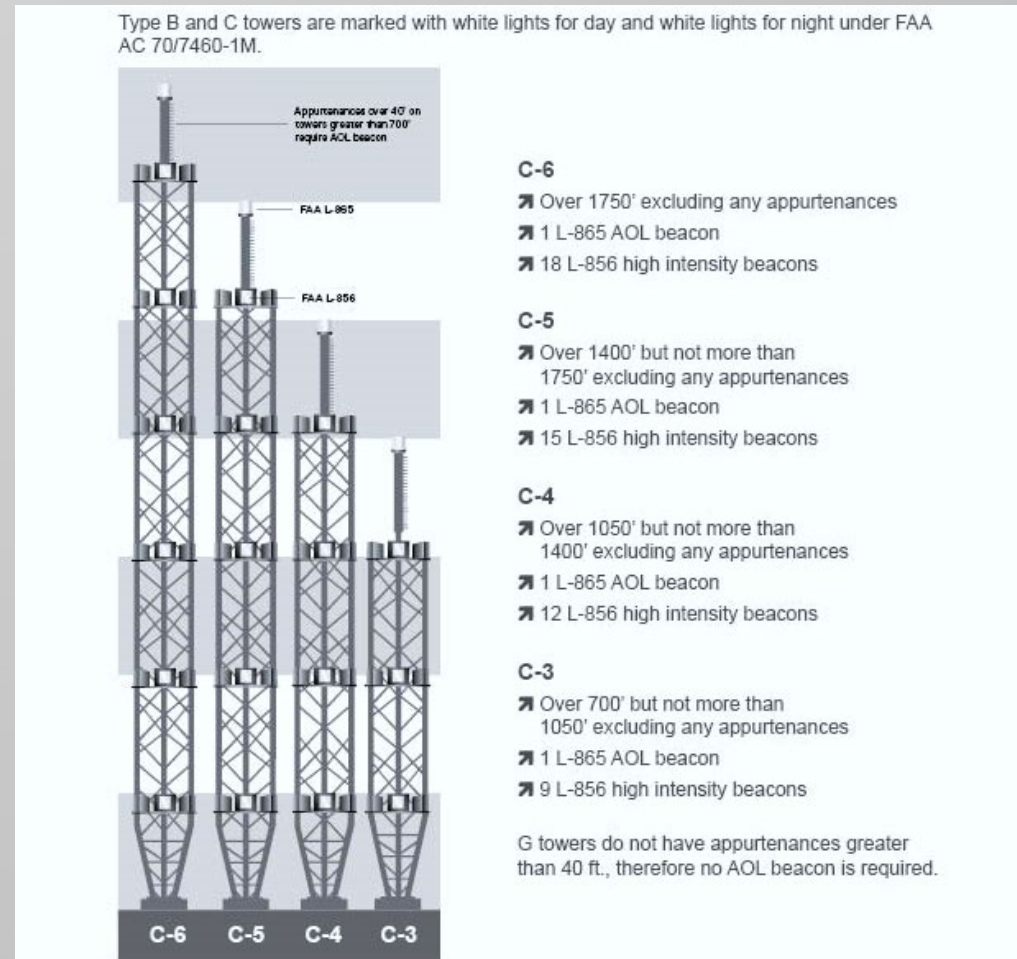
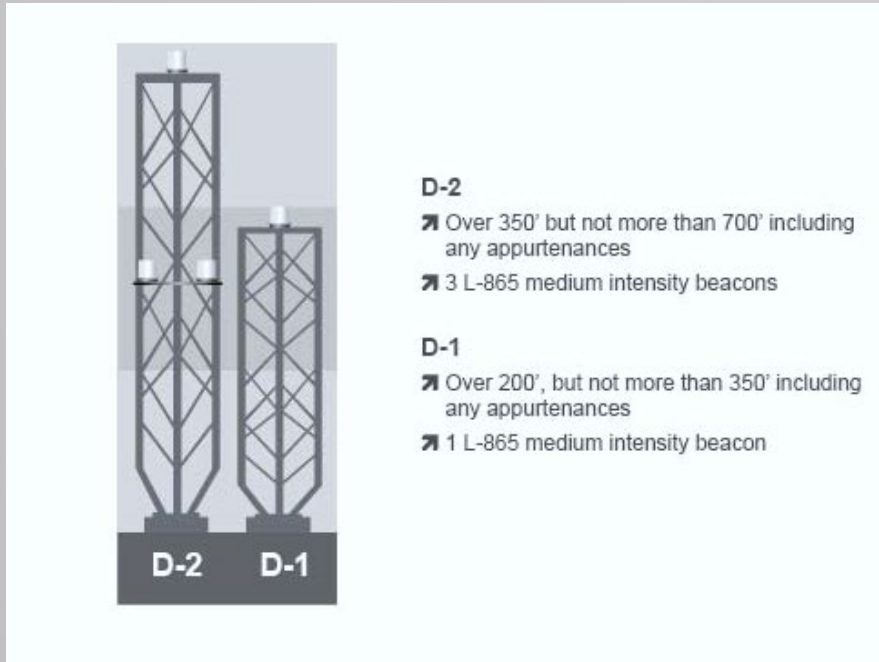


Low, Medium, and High Intensity Lighting



- Low intensity systems have lower power lights and can be supported by low voltage or AC Power.
- Medium intensity systems are typically single phase for towers 350 feet and below.
- High intensity systems provide bright or constant lighting and are supported by high voltage/AC power systems.

FAA Tower Lighting Standards



SECTION 16

KEY POINTS

1. What is a capacitor.
2. Differences between low, medium, and high intensity lighting systems.
3. FAA tower lighting standards.

SECTION 17

SUMMARY

1. Always assume electrical circuits and or conductors are energized.
2. Always maintain MAD for you and equipment.
3. Lockout/tagout.
4. Test before touch.
5. Grounding and bonding.
6. Only your employer can designate you as a qualified employee.

SAFETY NEVER ENDS

Remember...

**You are
responsible for
your safety.**

