NATE
THE COMMUNICATIONS INFRASTRUCTURE CONTRACTORS ASSOCIATION

NATE WIN
WIRELESS INDUSTRY NETWORK

Electrical Safety Awareness for Telecom Workers Training Course

STUDENT WORKBOOK

605-882-5865
natehome.com

This material was produced under grant number SH-39154-SH2 from the Occupational Safety and Health Administration, U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Curriculum Development Team

Richard Cullum, P.E., CWI, CGC

Dave Hall
Vice President Safety & Training
Nexius

Kenneth Hill
Safety Program Manager
Crown Castle

George Kerstetter
Director Outside Plant
Beehive Broadband

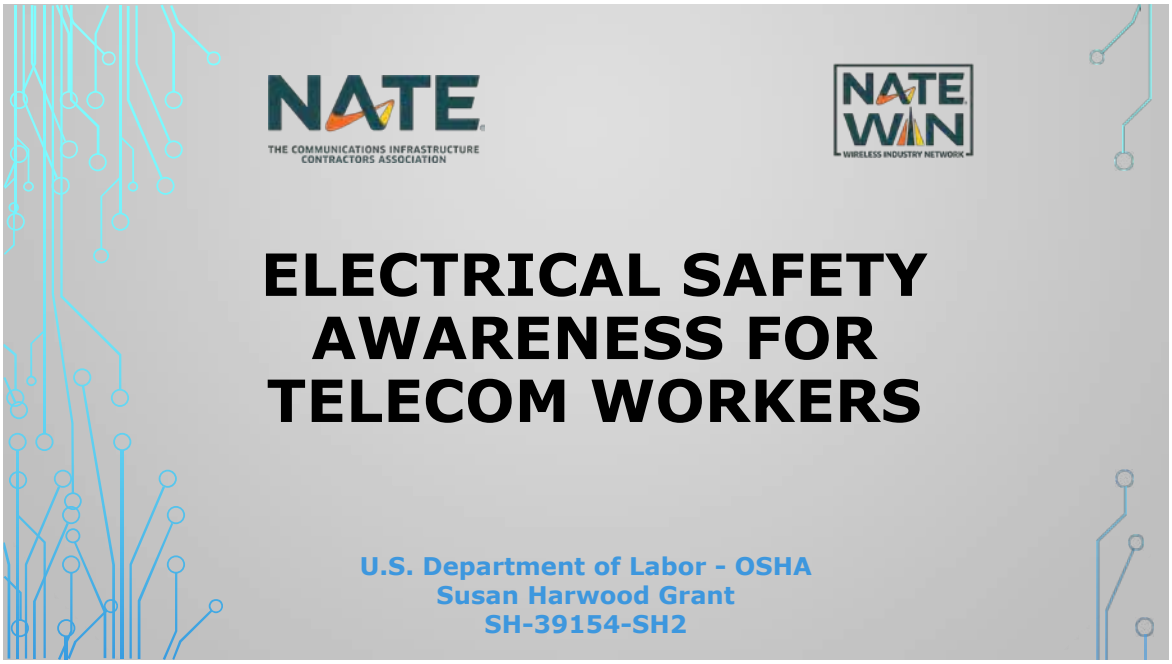
Jason "Corey" Manus
Director, Wireless Construction
Tilson Technology Management, Inc.

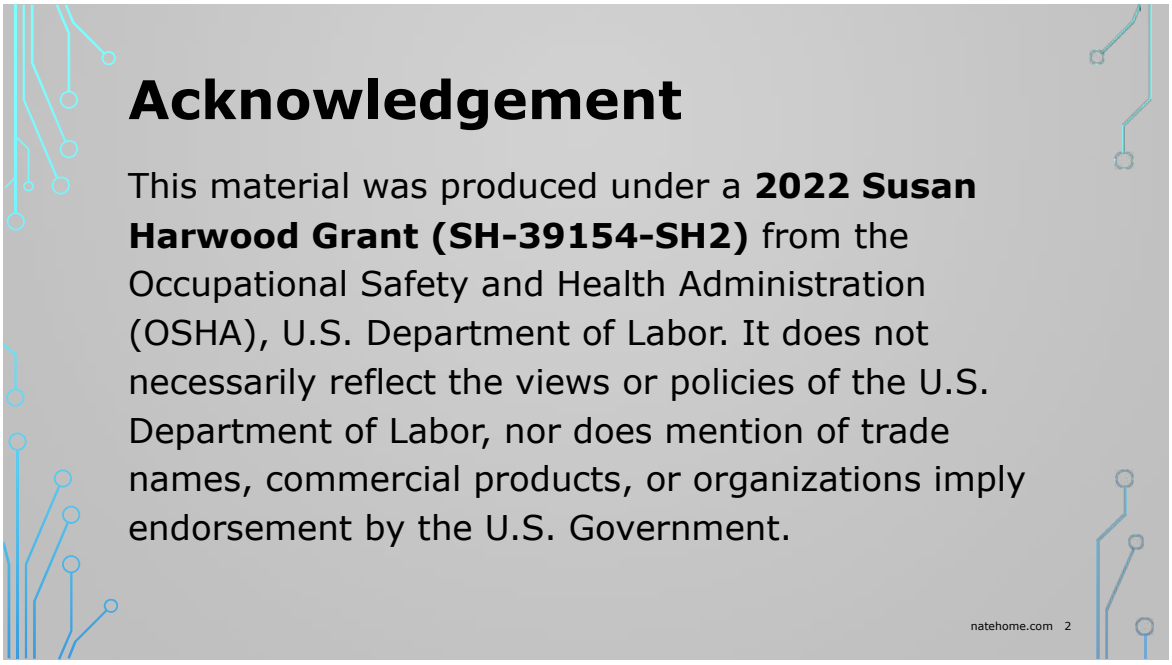
Nick Wilkerson, CSP
Sr. Director, Risk Management
SBA Network Services, LLC

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.

Table of Contents


NATE
THE COMMUNICATIONS INFRASTRUCTURE CONTRACTORS ASSOCIATION
NATE WIN
WIRELESS INDUSTRY NETWORK
ELECTRICAL SAFETY AWARENESS FOR TELECOM WORKERS
U.S. Department of Labor - OSHA
Susan Harwood Grant
SH-39154-SH2


Acknowledgement
This material was produced under a 2022 Susan Harwood Grant (SH-39154-SH2) from the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor. It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.
natehome.com 2

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.

natehome.com 3

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.

natehome.com 4

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.

natehome.com 5

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

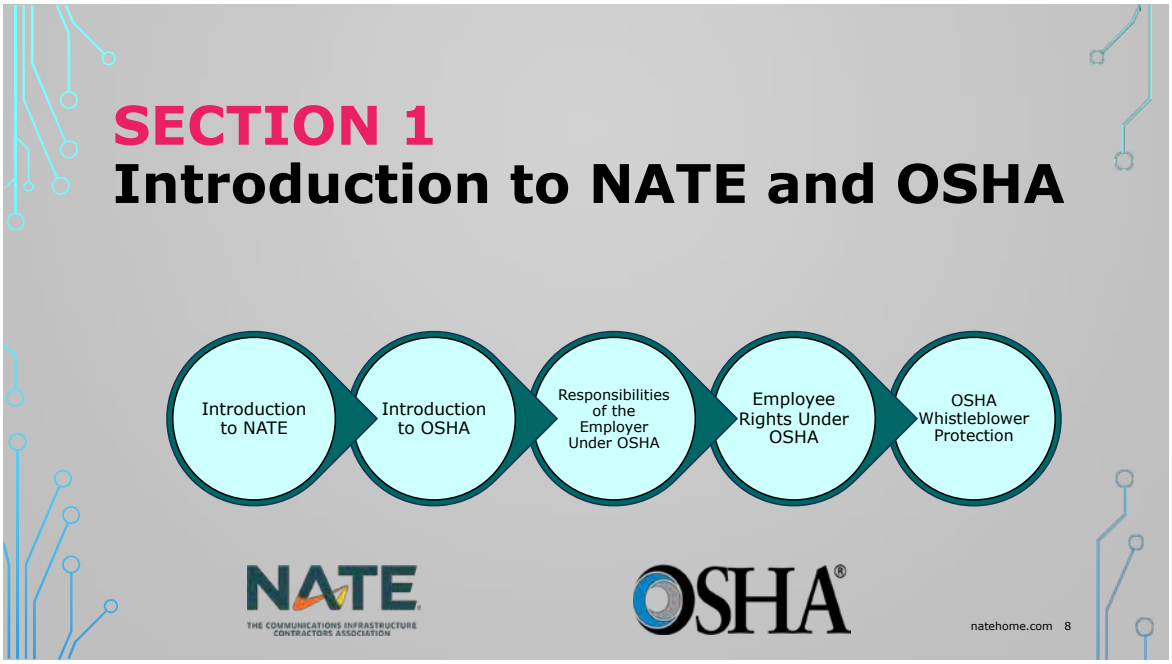
natehome.com 6

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

natehome.com 7

OSHA Information for Employers and Employees



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.

OSHA®

natehome.com 10

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.

natehome.com 11

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

natehome.com 12

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.

natehome.com 13

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

natehome.com 14

OSHA Whistleblower Protection

- Visit 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).

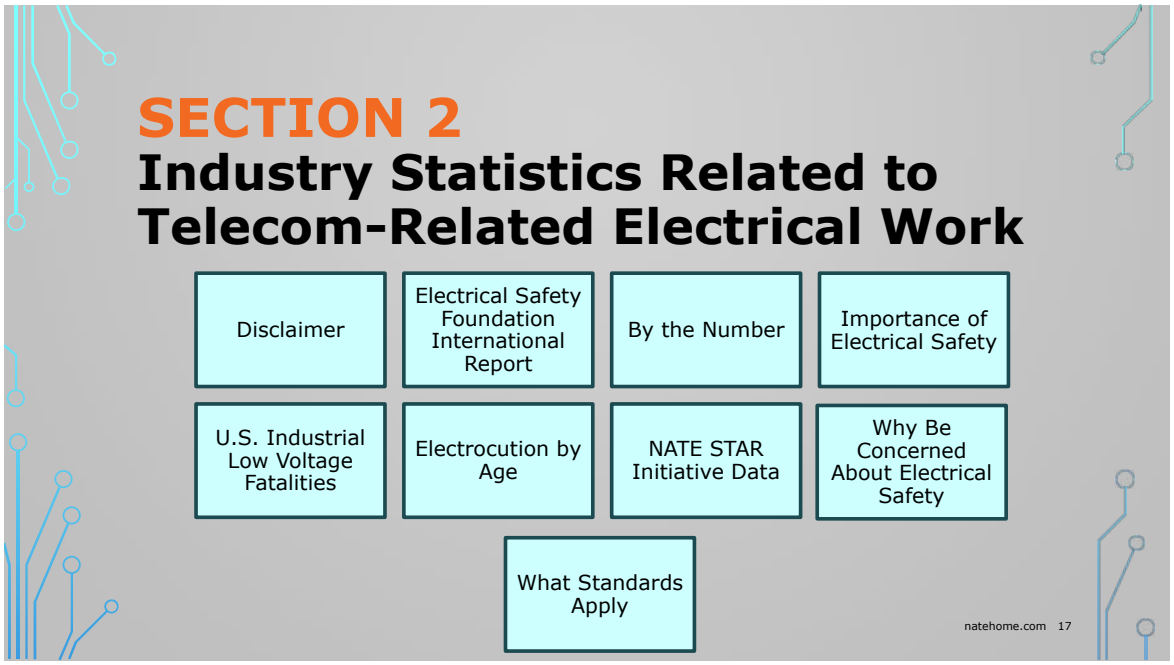
Source: OSHA 3021-09R 2011, www.osha.gov/workers

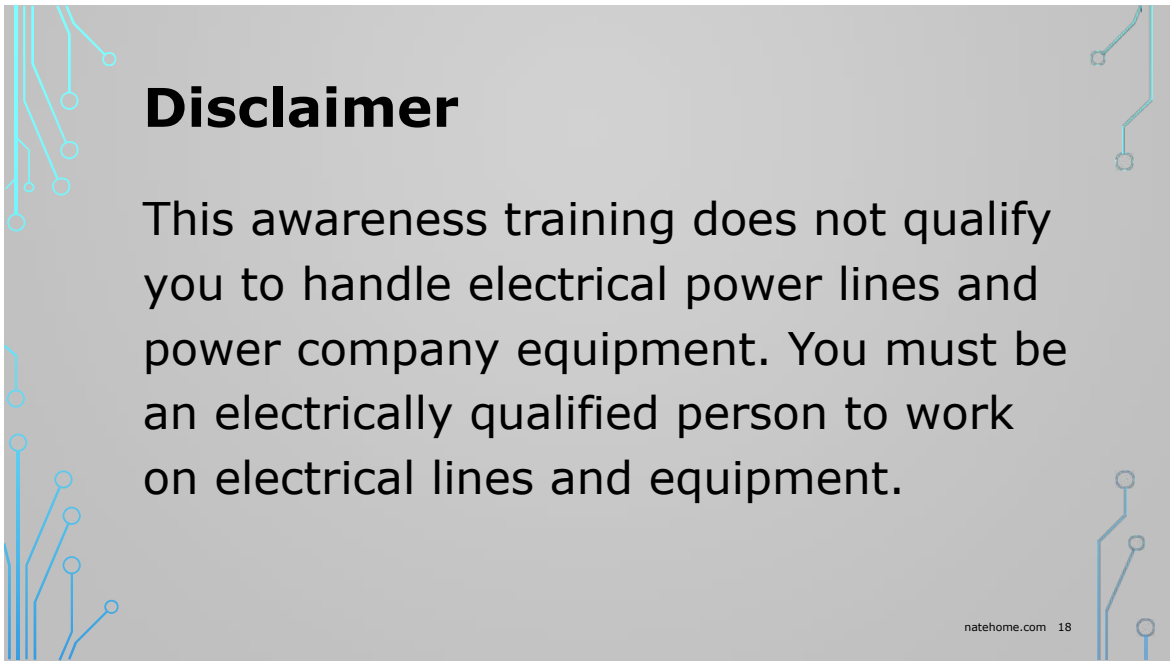
natehome.com 15

SECTION 1
KEY POINTS

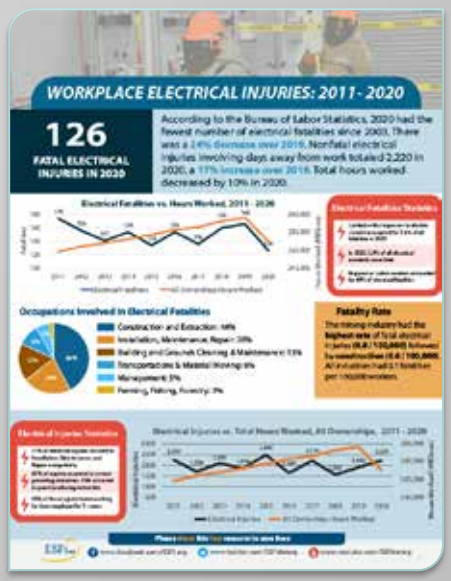
1. OSHA (Occupational Safety and Health Administration).
   a. Regulatory agency of the federal government.
   b. Established to ensure that the law is adhered to by regulating employers.
2. Employers are responsible for protecting their employees.
3. Workers have rights.
4. OSHA whistleblower protection.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

natehome.com 16


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
natehome.com 17


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.
natehome.com 18

Electrical Safety Foundation International (EFSI) Report



https://www.esfi.org/workplace-safety/workplace-injury-fatality-statistics/

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**

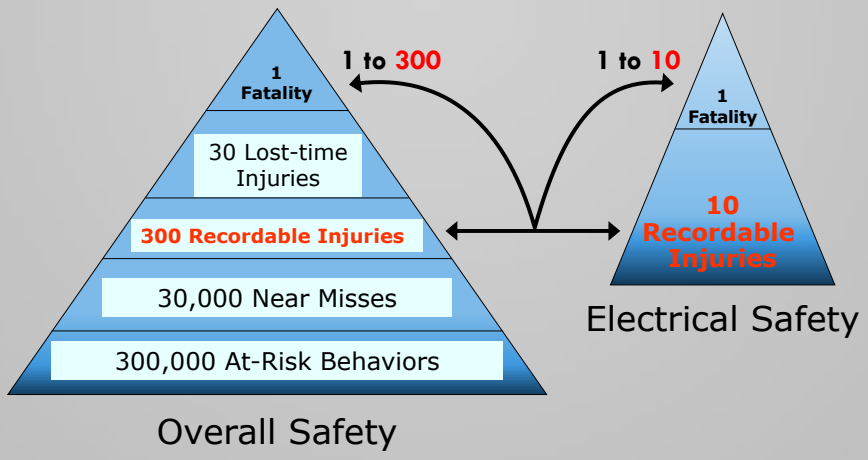
+1,800 Workplace fatalities from exposure to electricity

Every other day

1 ***Worker is electrocuted***

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

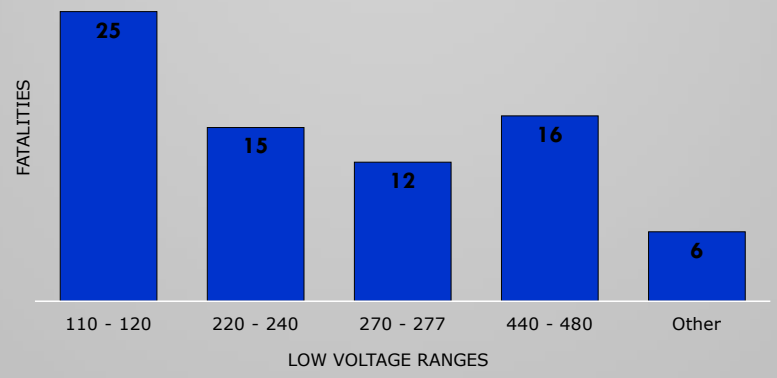
Importance of Electrical Safety



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

natehome.com 21

U.S. Industrial Low Voltage* Fatalities

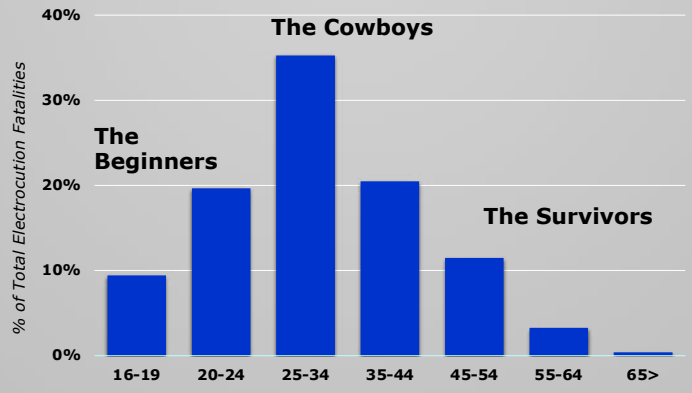


*<600 volts

Data from NIOSH 98-131

natehome.com 22

Electrocution by Age



Data from NIOSH 98-131

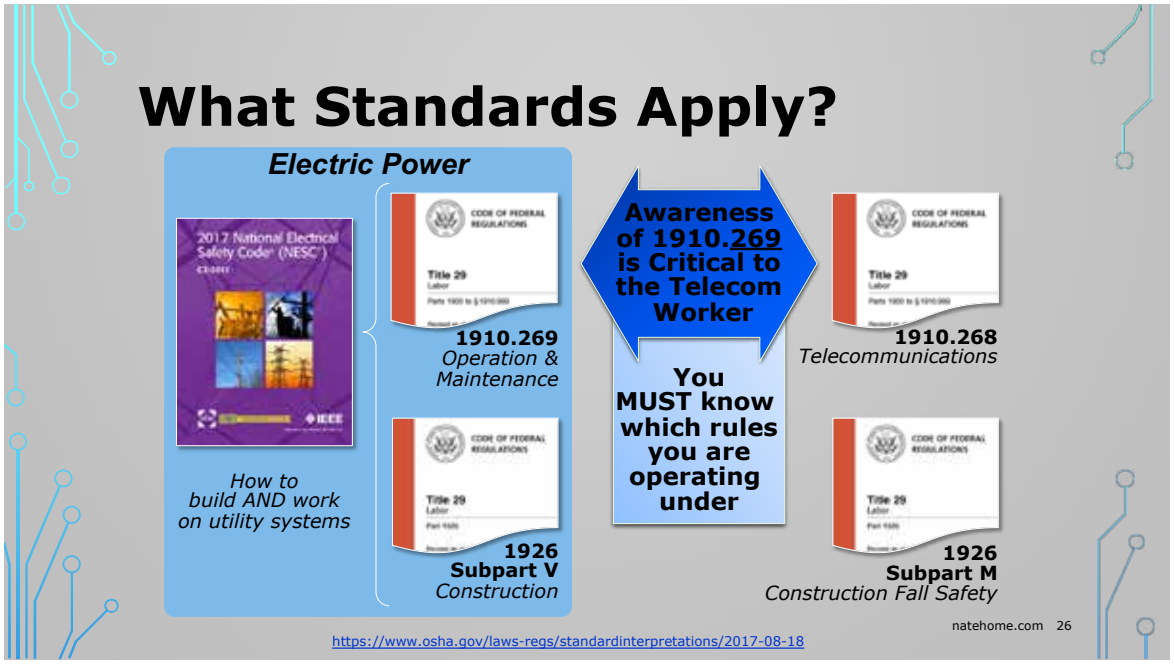
natehome.com 23

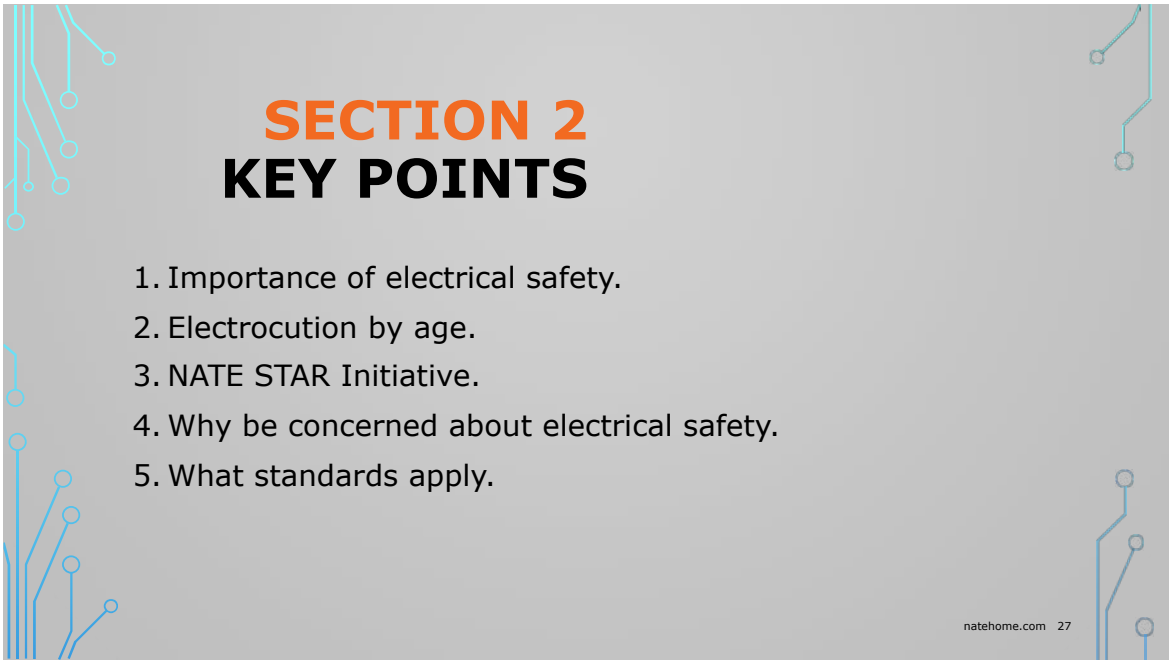
NATE STAR Initiative Data 2017-2021

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

natehome.com 24


Why Be Concerned About Electrical Safety
Ocala, FL Employee Is Electrocuted While Installing Fiber Optic Cable
Puerto Rico and Utica, MS Puerto Rico death is 2nd industry tower tech fatality in April
8 Nov. 2016
22 Oct. 2019
12 Feb. 2009
2 Apr. 2018
Sterling, IL Communications worker electrocuted working on utility pole
Greenfield, Wisconsin Man dead, another hurt after being electrocuted near 84th and Layton in Greenfield
natehome.com 25


What Standards Apply?
Electric Power
2017 National Electrical Safety Code® (NESC®)
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
https://www.osha.gov/laws-regs/standardinterpretations/2017-08-18
natehome.com 26


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.
natehome.com 27

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)

natehome.com 28

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.

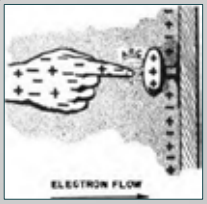
natehome.com 29

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.

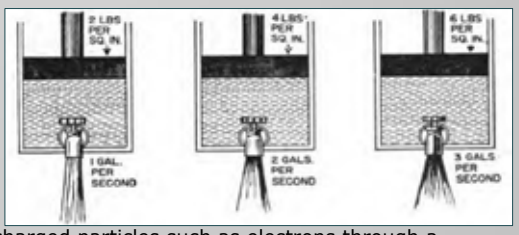
Potential – Every charged object has a certain potential and when two charged objects have different potentials, electrons tend to move because of the potential difference. **Basically, potential differences cause electrons to flow.**

natehome.com 30

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

natehome.com 31

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

natehome.com 34

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.

natehome.com 35

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.

natehome.com 38

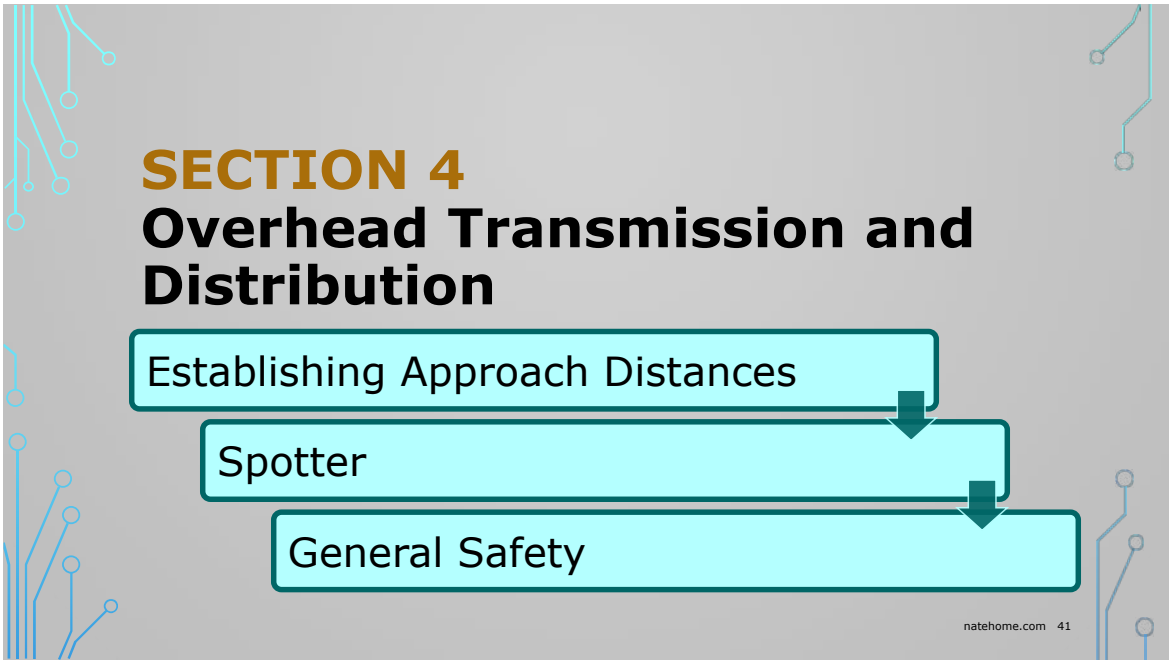
Voltage Detectors

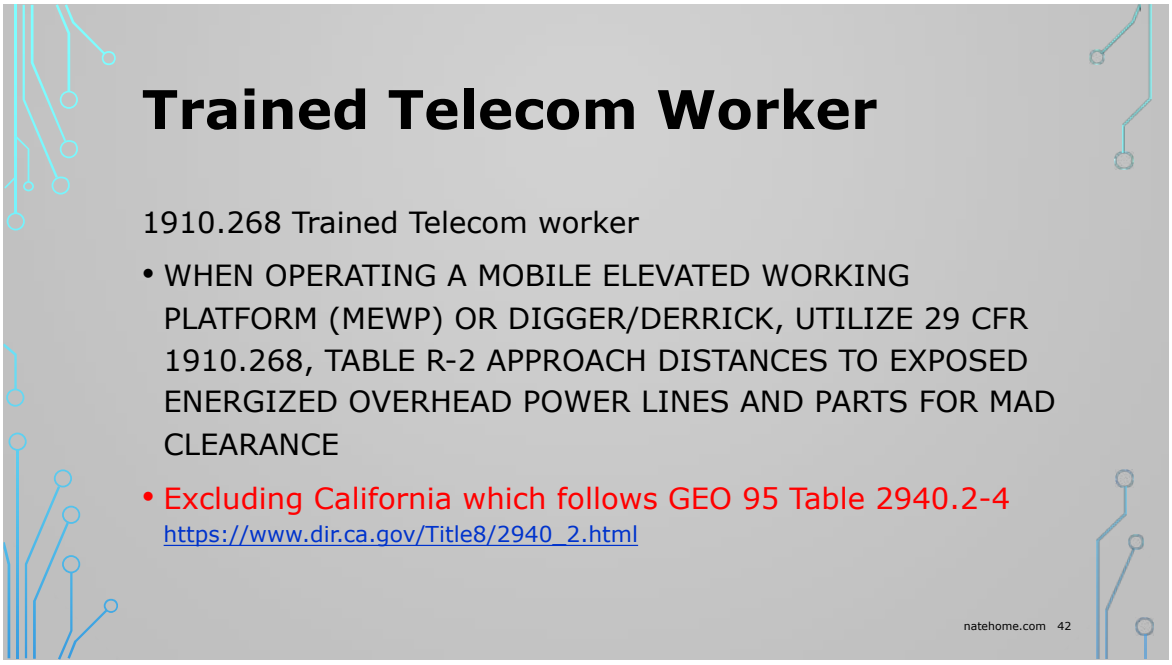
natehome.com 39

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.

natehome.com 40


SECTION 4
Overhead Transmission and Distribution
Establishing Approach Distances
Spotter
General Safety
natehome.com 41


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
natehome.com 42

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.*

natehome.com 43

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."

natehome.com 44

Failure to Maintain MAD

September 2022 fatality in Virginia

natehome.com 45

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)

This table shows the minimum clearance distances, in feet, for different power line voltages. Source: OSHA

natehome.com 46

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 drive is unable to see or hear by themselves.

natehome.com 47

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.

natehome.com 48

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.

natehome.com 49

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.

natehome.com 50

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

- Unsafe Work Practices
- Potential Outcomes
- Non-fatal Shocks
- Call 911 and Then the Local Power Company
- Assume Downed Lines Are Live
- Overhead Hazards
- Step Potential and Touch Potential

natehome.com 51

Unsafe Work Practices Can be Deadly!

natehome.com 52

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.

natehome.com 53

Non-fatal Shocks Can Result in Severe Burns

natehome.com 54

Call 911 and Then the Local Power Company

natehome.com 55

Always Assume Downed Lines Are Live

natehome.com 56

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!

natehome.com 57

Downed Power Line

New Jersey utility worker narrowly escapes power line fire.

Courtesy of Crown Castle

natehome.com 58

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.

natehome.com 59

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=Step+Touch+Potential+Demonstration&aqs=chrome..69i57j0i22i30j0i390.11071j0j15&sourceid=chrome&ie=UTF-8#fpstate=ive&vld=cid:cfc8982c,vid:E_0ug-mngLM.

natehome.com 60

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

natehome.com 62

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.

natehome.com 63

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)

natehome.com 64

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)

natehome.com 65

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)

natehome.com 66

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)

natehome.com 67

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)

natehome.com 68

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!**

natehome.com 69

SECTION 7
Equipment

- Don't Become Path the Ground
- If You Make Contact
- Aerial Equipment
- Other Equipment
- Excavating Equipment
- Rigging Systems

natehome.com 70

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.

natehome.com 71

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.

natehome.com 72

Aerial Equipment

Path to ground

natehome.com 73

Miscellaneous

74

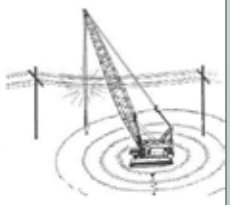
Pump Truck

natehome.com 75

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



natehome.com 76

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

natehome.com 77

Excavating Equipment



natehome.com 78

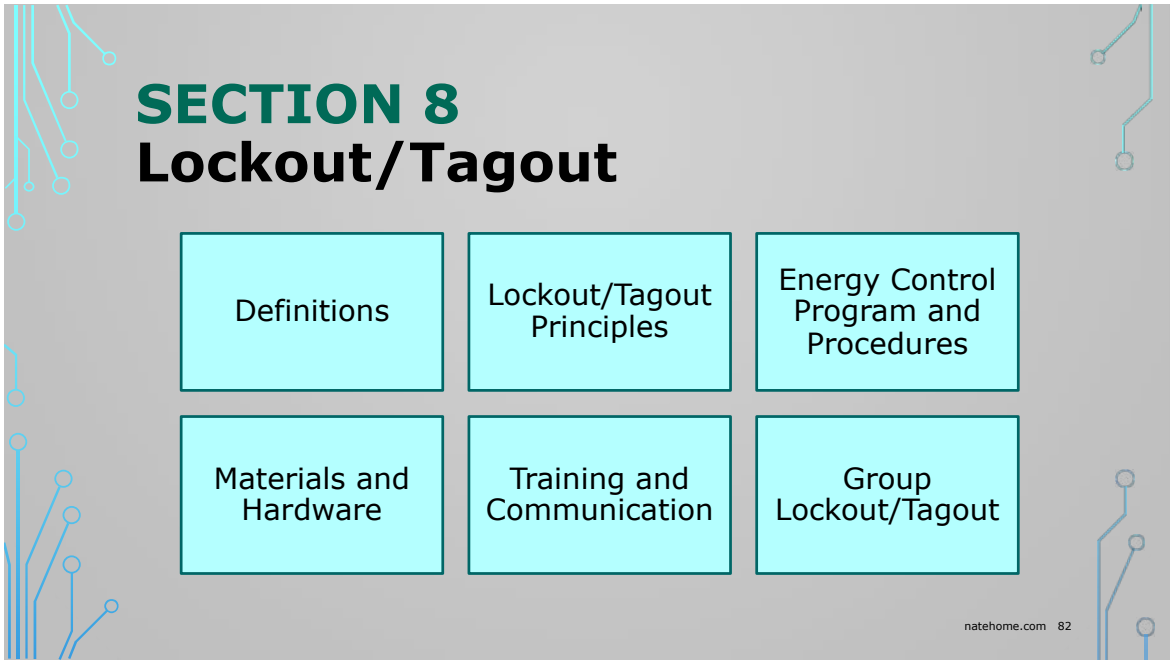
Derrick

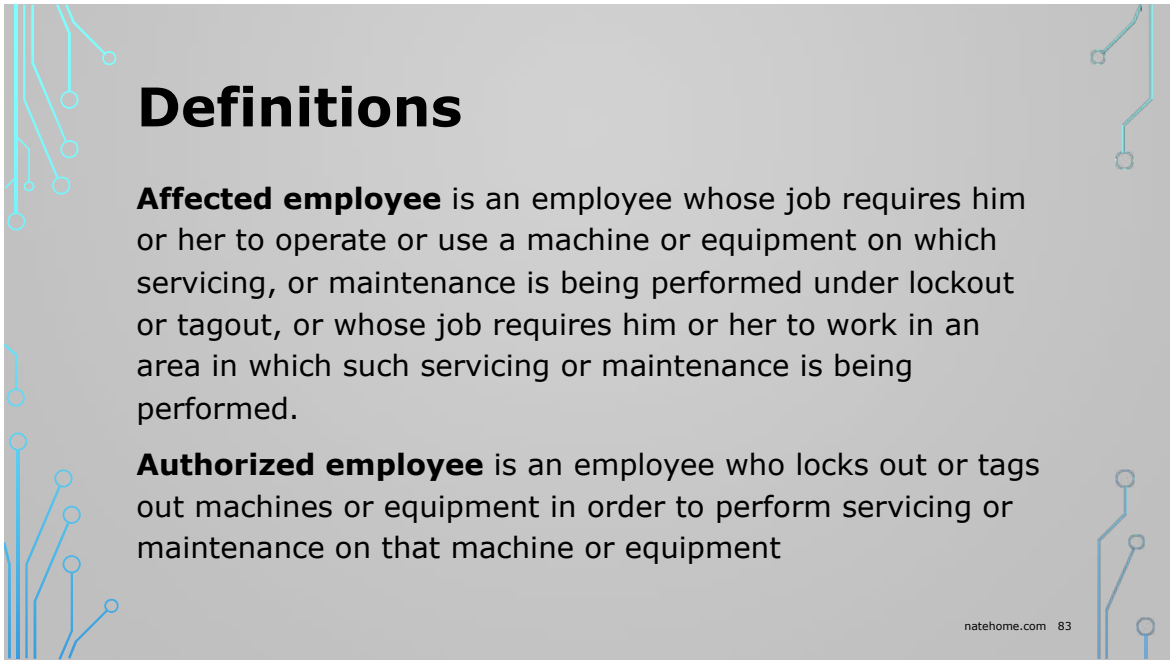

natehome.com 79

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
natehome.com 82


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
natehome.com 83

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.

natehome.com 84

Forms of Control of Hazardous Electrical Energy

- Simple Lockout/Tagout
- Complex Lockout/Tagout

natehome.com 85

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.

natehome.com 88

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

natehome.com 89

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.

natehome.com 90

Materials and Hardware – Locks and Tags

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

natehome.com 91

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

natehome.com 92

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.

natehome.com 93

Energy Isolation

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

natehome.com 94

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.

natehome.com 95

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

natehome.com 96

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.

natehome.com 97

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

natehome.com 98

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.

natehome.com 99

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.

natehome.com 100

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

natehome.com 101

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.

natehome.com 102

Extension Cords

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

natehome.com 103

Electricity

natehome.com 104

Related Work Activities

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

natehome.com 105

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.

natehome.com 106

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.

natehome.com 107

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

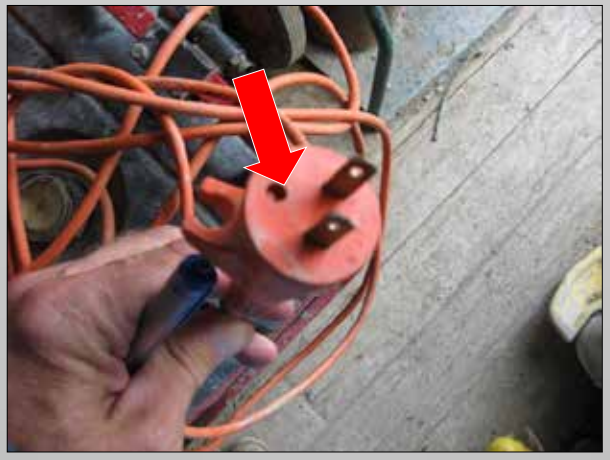
natehome.com 108

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!**

natehome.com 109

Danger! Missing Ground Prong



natehome.com 110

Do Not Use!

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

natehome.com 111

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.

natehome.com 112

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.

natehome.com 113

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.

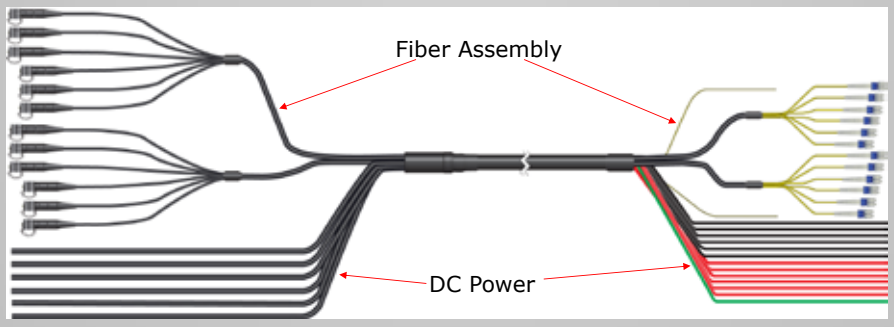
natehome.com 114

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

natehome.com 115

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

natehome.com 116

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

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

natehome.com 117

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

natehome.com 118

Termination and Installation

A technician terminates DC power in a Raycap Inverter

An electrician installs a backup battery system for highway lighting

natehome.com 119

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

natehome.com 120

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

natehome.com 121

Stray Voltage Safety Alert

Crown Castle – Safety 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.
- 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.

natehome.com 122

Crown Castle – Safety Alert 2021-03

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.

natehome.com 123

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.

natehome.com 124

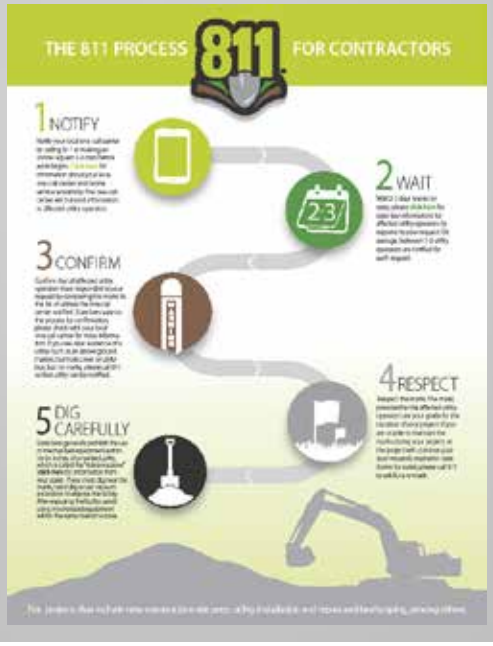
SECTION 11
Underground Power

Call Before You Dig	Locating Equipment	Potholing (Positively exposing underground utilities)
• 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	• Ground Penetrating Radar (GPR) • Electromagnetic Locating Device	• Proper methods to physically locate facilities • Soft dig methods

natehome.com 125

Call Before You Dig

www.commongroundalliance.com



natehome.com 126

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

natehome.com 127

Locating Equipment

natehome.com 128

Warning Tape

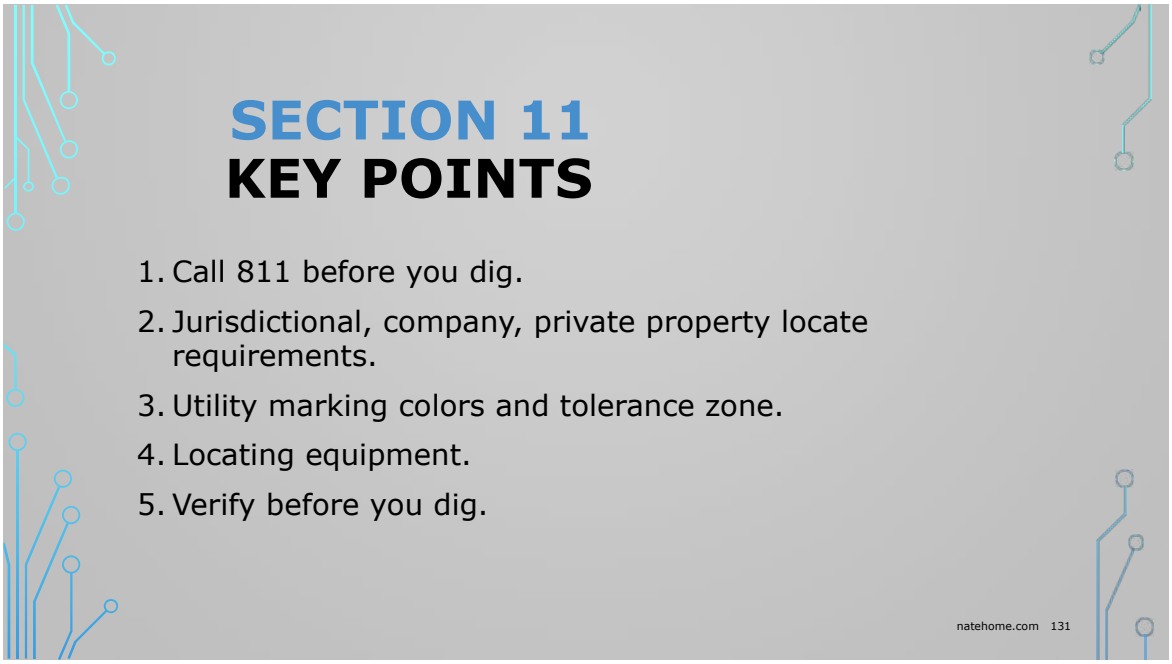
- Here a trenching crew installs warning tape to identify where buried conductors are located.
- Warning tape is placed per the construction drawings usually between 16 and 24 inches above the cables which are being marked.
- Provides another layer of identification outside locate services to help prevent 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.
natehome.com 131

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

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

Earth Grounding For Worker Protection

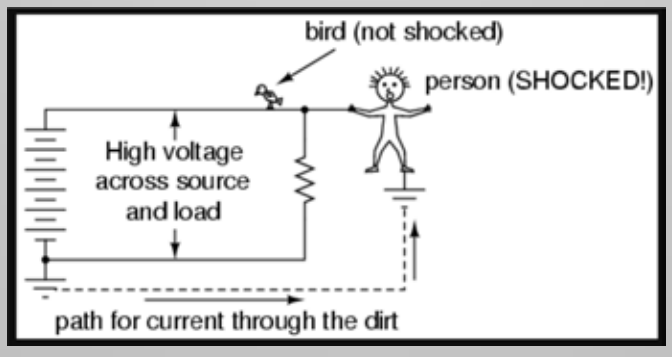
Most electrical accidents result from one of the following three factors:

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

natehome.com 136

Grounding

Electrically connecting communication hardware to an effective electrical ground.

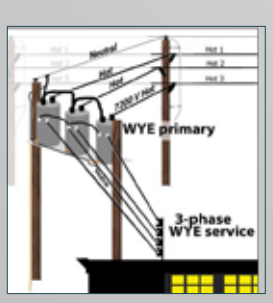


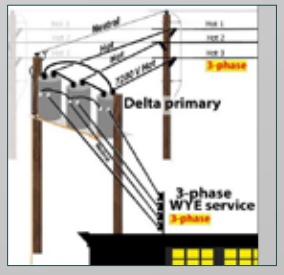
natehome.com 137

Grounding for Equipment

Two Systems:

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





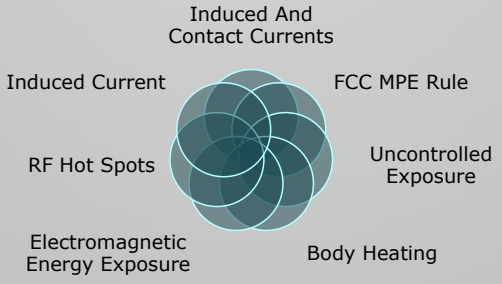
natehome.com 138

SECTION 12
KEY POINTS

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

natehome.com 139

SECTION 13
Induced Current



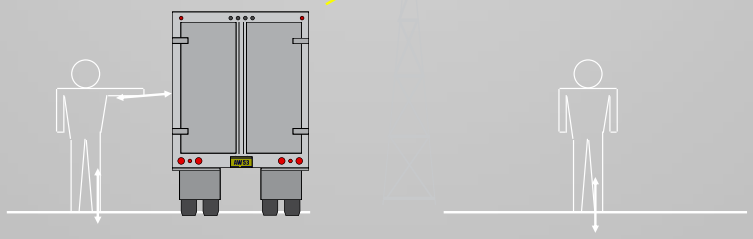
natehome.com 140

Induced and Contact Currents

Two Scenarios:

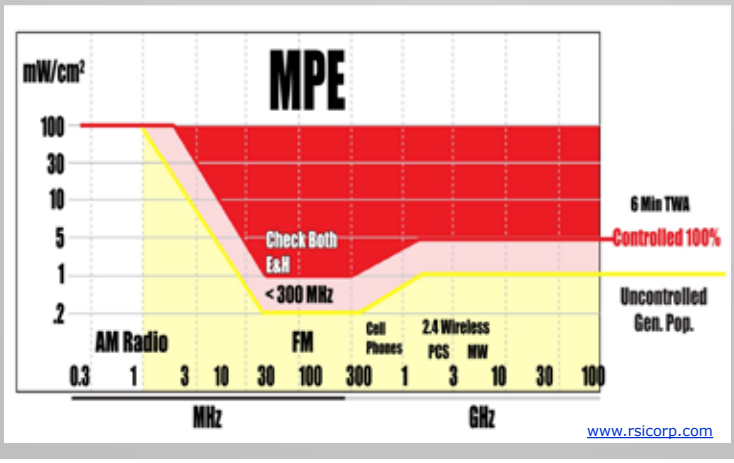
- RF induces voltage in ungrounded conductor.
- Person acts as current path to ground by touching charged conductor.

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



natehome.com 141

FCC Maximum Permissible Exposure (MPE) Rule



natehome.com 142

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.

natehome.com 143

Body Heating

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

natehome.com 144

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.

natehome.com 145

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.

natehome.com 146

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.

natehome.com 147

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.

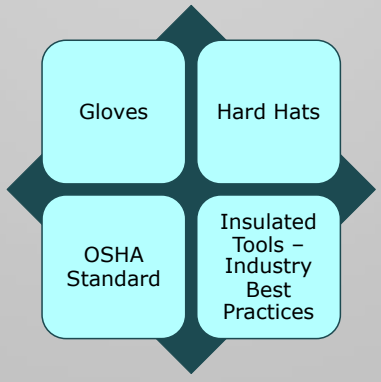
natehome.com 148

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.

natehome.com 149

Section 14
Personal Protective Equipment (PPE)



natehome.com 150

Gloves

Leather gloves for grounding and less than 50V work.

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

natehome.com 151

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).

natehome.com 152

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.

natehome.com 153

Insulated Tools – Industry Best Practice

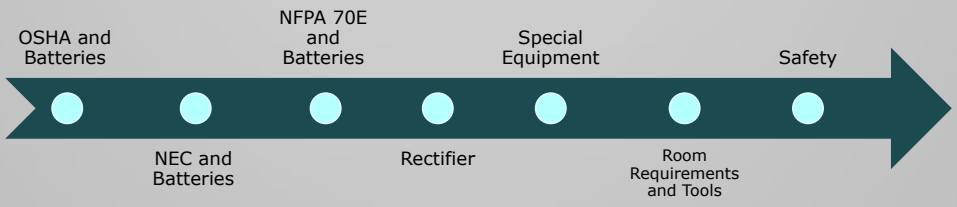
natehome.com 154

SECTION 14
KEY POINTS

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

natehome.com 155

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, H_2O 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)

natehome.com 158

The NEC and Batteries

NFPA 70 (National Electrical Code)

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

natehome.com 159

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.

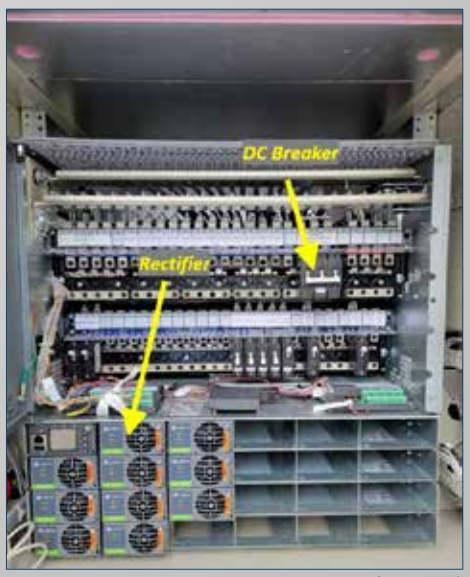
- Arc Flash generally not required for nominal 50V or less.
- General Telecom Equipment is typically -48V DC.

natehome.com 160

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).



natehome.com 161

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.

NFPA 70E Article 480

natehome.com 162

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.

natehome.com 163

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

natehome.com 164

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.

natehome.com 165

SECTION 16
Tower Lighting and Capacitors

- What is a Capacitor
- Low, Medium, and High Intensity Lighting
- FAA Tower Lighting Standards

natehome.com 166

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.

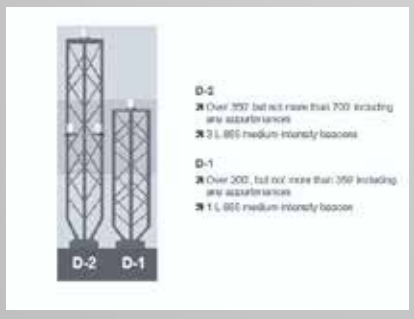
natehome.com 167

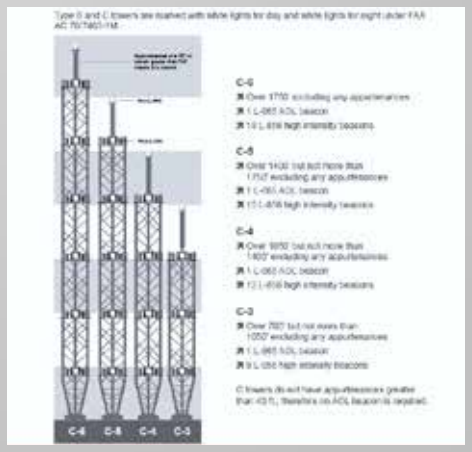
Low, Medium, and High Intensity Lighting

- 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.

natehome.com 168

FAA Tower Lighting Standards





https://www.faa.gov/documentLibrary/media/Advisory_Circular/Advisory_Circular_70_7460_1M.pdf

natehome.com 169

SECTION 16
KEY POINTS

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

Summary

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.

natehome.com 171

SAFETY NEVER ENDS

Remember…

You are responsible for your safety.

natehome.com 172

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.

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.
- 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).

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.

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

APPENDIX SECTION 10

SAFETY DEPARTMENT

SAFETY ALERT

FOR EXTERNAL USE

CROWN CASTLE

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 where 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.

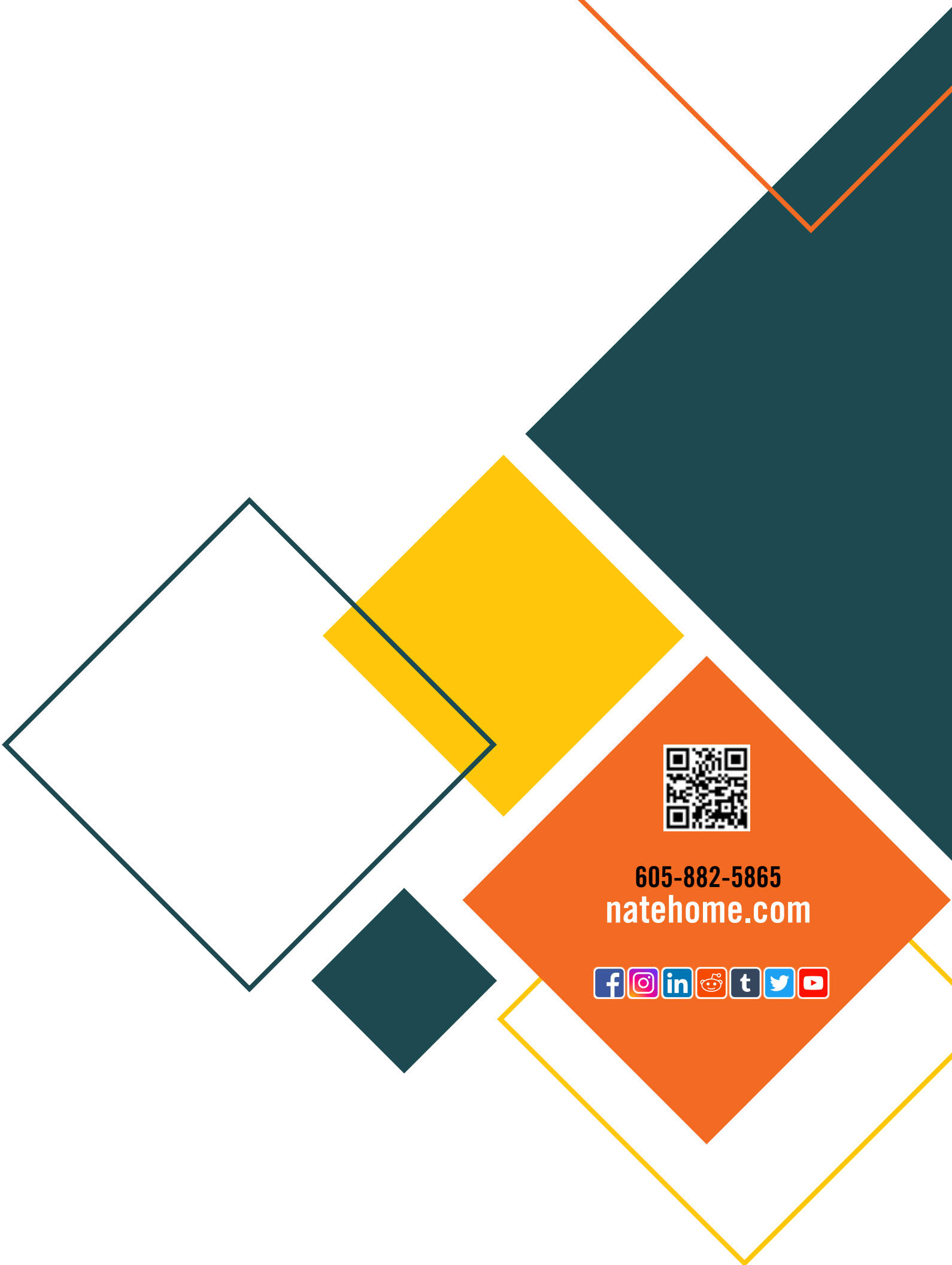
Working on live electrical circuits can cause shocks, burns, explosions, and death. Live circuits should be de-energized and have a Lock Out / Tag Out (LOTO) performed whenever possible. All electrical wires, including grounding wires should be treated as energized as stray voltage and current may be 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.


605-882-5865
natehome.com