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Electrical Safety

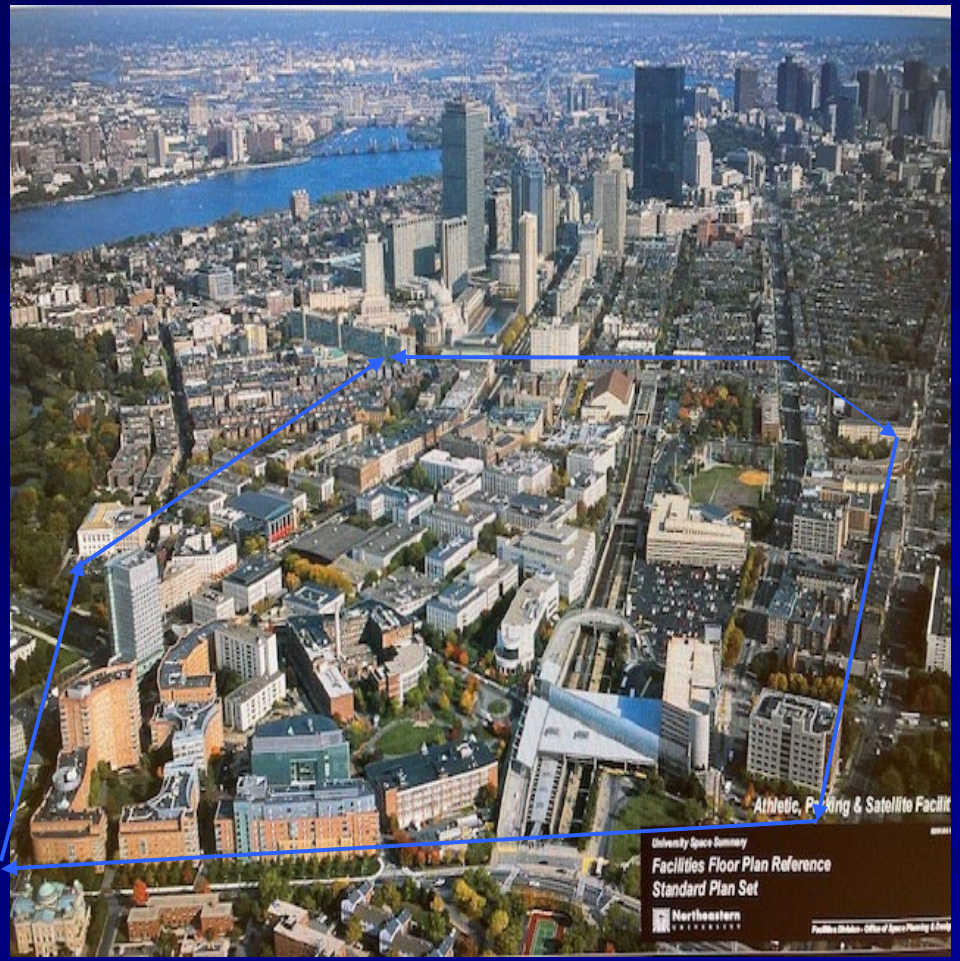
FUNDAMENTALS

600 Volts or Less

Learning Objectives:

- Electrical Hazards in the workplace. “ FUNDAMENTALS “
- 2024 Changes NFPA 70E.
- Grounded vs. Ungrounded Systems
- Battery Systems

Ken Andrea Sr.



Northeastern University

Ken Andrea Jr.

Woburn Ring Station - 315kv 118kv 15kv

Assessment for Voltage Safety

OSHA requires that circuit parts operating at _____volts or greater be de-energized before anyone works on or near them

A - 50v

B - 120v

C- 240v

D- 480 v

Assessment for Voltage Safety

An electrical ARC can reach temperatures as high as that of the Sun’s surface

True

False

Assessment for Voltage Safety

Once placed into service, rubber gloves must be cleaned, inspected, and electrically tested every _____months

A- 2 months

B- 3 months

C- 6 months

D- 12 months

~ Module 1 ~

Electrical Safety Overview

“Fundamentals”

What are the Electrical Hazards?

- Electric Shock
- Arc Flash
- Arc Blast
- Other hazards - Chemistry

SHOCK

FLASH

Arc Blast

ARC FLASH

Calorie of HEAT

(cal/cm^2)

Calorie: Amount of energy required to raise the temperature of one gram of water one Celsius degree

If you take a disposable lighter and put your palm in the hottest part of the flame for one second, you will receive about 1.2 calories per cm^2 — the onset of a second degree burn (blister burn)

What do you need?

- OSHA Regulations = SHALL (not optional)
- NFPA -70E = HOW (best practice)
- NFPA -70B
- Employer = Implementation

OSHA：Are the minimum requirements, they do not provide the prescribed (how to) requirements to comply with their regulations.

NFPA 70E

WHAT IS IT?

NFPA 70E

- It is a consensus document intended to assist electrical workers in the field in evaluating the level of electrical hazards. (Field Manual)
- When 70E states it's "permitted," it means it's an option /can be used, but it's not mandatory. (NO Enforcement)
- Understanding the "scope of the work" being performed is critical to how 70E safety recommendations could be applied.
- Based on General Industry 29-CFR 1910 OSHA Final Rule 02/14/07

OSHA: Asks

Is there a potential hazard(s) present YES or NO, requires a job hazard analysis.

Requires verification for the absence of voltage: "WERE YOU ARE EXPOSED"

NFPA 70E: Allows

Risk Assessment: For likelihood of occurrence, potential severity, and frequency over a given time period. Verification for the absence of voltage *" At each point of Work" (new 2024)*

Risk Assessment: 70E

The conclusion is directly proportional to the **user's** understanding of the risks involved.

- To minimize Risk

OSHA
Absence of Voltage Verification

1910.333(b)(2)(vii)(B)

- A **qualified person** shall use **test equipment** to test the circuit elements and electrical parts of equipment to **which employees will be exposed** and shall verify that the circuit elements and equipment parts are de-energized.

~ NFPA 70E ~

Establishing Safe Work Conditions

Added: *"at each point of work"* to the step regarding how to test for the absence of voltage

120.6 (7) page 114

Allows for the use of adequately rated Outlet Circuit Testers to test each phase conductor or circuit part "at each point of work" to test for the absence of voltage.

TEST EQUIPMENT

- OSHA

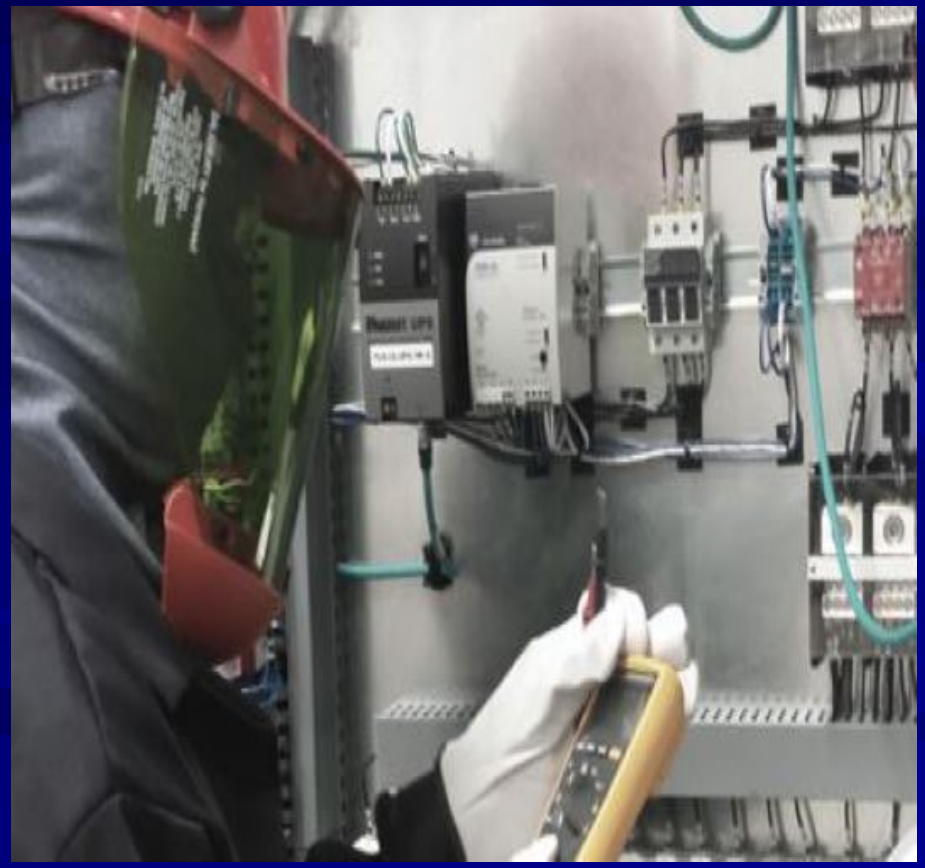
UL 61010 – Electrical Equipment for measurement, control, and laboratory use. "Test Equipment"

- NFPA 70E

UL 1436 - Standard for Outlet Circuit Testers.

Absence of Voltage Verification

OSHA



70E

OSHA- Standard Interpretations

December 12, 2012

Your letter inquires about the use of light-emitting-diode LED-type devices for the purpose of meeting the verification requirements for lockout-tagout procedures under OSHA's general industry standards.

- Question 1: Can the device described above be used to verify that isolation and de-energization of machine or equipment have been accomplished under 1910.147(d)(6)?[2]
- Question 2: Can the type of device described above be used to meet the lockout and tagging 29 CFR Part 1910, Subpart S requirements under 1910.333(b)(2)(iv)(B)?[4]
- Question 3: Could an employee, who may/may not be a qualified person under 29 CFR Part 1910, Subpart S, use the LED-type devices and implement the detailed sequential procedure to verify that circuit elements and equipment are de-energized before an employee who may / may not be a qualified person, works on or near them?

- **Response: NO**

OSHA ~ Requires the use of "Test Equipment" - UL 61010

NFPA 70E ~ Allows for "Outlet Circuit Tester" - UL 1436

29 CFR 1910
General Industry Standard Live work tasks

- Voltage Testing
- Troubleshooting, Diagnostics
- Start up of equipment (frequency, voltage adjustments)
- LO/TO of electrical hazards 1910.333 (b)(2) verification

Requires worker to wear appropriate PPE based on the hazard(s)

Arc Flash Magnitude

- Two of the components (there are several)
  - Available fault current
  - Tripping time of the OCPD

- Arc Flash calculations are based on the assumption that the fault current information is correct and the OCPD trips within its prescribed range.

  Maintenance will influence the trip time

2015


Electrical Safety
PERSONAL PROTECTIVE EQUIPMENT
CATEGORY 0
Protective Clothing:
Non-melting or untreated natural fiber.
With a fabric weight of at least 4.5 oz/yard2
Protective clothing must be labeled
Shirt (long sleeve)
Pants (long)
Protective Equipment
Safety glasses
Hearing protection (ear canal inserts)
Heavy duty leather gloves (See Note 1)
CATEGORY 1
Protective Clothing:
Arc-rated Clothing:
Minimum arc rating of at least 4 cal/cm2
Arc-rated clothing must be labeled.
Arc-rated shirt (long sleeve) and pants or arc-rated coverall
Arc-rated face shield
Protective Equipment
Hard hat
Safety glasses
Hearing protection (ear canal inserts)
Heavy duty leather gloves (See Note 1)
Leather work shoes
CATEGORY 2
Protective Clothing:
Arc-rated Clothing:
Minimum arc rating of at least 8 cal/cm2
Arc-rated clothing must be labeled.
Arc-rated shirt (long sleeve) and pants or arc-rated coverall
Arc-rated face shield and balaclava or arc-rated flash suit hood
Protective Equipment
Hard hat
Safety glasses
Hearing protection (ear canal inserts)
Heavy duty leather gloves (See Note 1)
Leather work shoes
CATEGORY 3
Protective Clothing:
Arc-rated Clothing:
Minimum arc rating of at least 25 cal/cm2
Arc-rated clothing must be labeled.
Arc-rated arc flash suit jacket and arc-rated arc flash suit pants or arc-rated coverall
Arc-rated arc flash suit hood
Protective Equipment
Hard hat
Safety glasses
Hearing protection (ear canal inserts)
Arc-rated gloves (See Note 1)
Leather work shoes
CATEGORY 4
Protective Clothing:
Arc-rated Clothing:
Minimum arc rating of at least 40 cal/cm2
Arc-rated clothing must be labeled.
Arc-rated arc flash suit jacket and arc-rated arc flash suit pants or arc-rated coverall
Arc-rated arc flash suit hood
Protective Equipment
Hard hat
Safety glasses
Hearing protection (ear canal inserts)
Arc-rated gloves (See Note 1)
Leather work shoes
Note 1: If rubber insulating gloves with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

2018

CATEGORY 1

What Personal Protection Equipment (PPE) You Shall Wear:
[X] Cotton Undergarments
[X] Arc Rated Long Sleeved Shirt (or FR Coveralls)
[X] Arc Rated Long Pants (or FR Coveralls)
[X] Hard Hat with Arc Rated Face Shield
[X] Hearing Protection (Inserts)
[X] Safety Glasses or Goggles
[X] Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes (as needed)

CATEGORY 2

What Personal Protection Equipment (PPE) You Shall Wear:
[X] Cotton Undergarments
[X] Short Sleeved "T" Shirt (Natural Fiber)
[X] Arc Rated Long Sleeved Shirt and Long Pants
or Arc Rated Coveralls instead
[X] Hard Hat with Arc Rated Face Shield w/Sock Balaclava
[X] Safety Glasses or Goggles
[X] Hearing Protection (Inserts)
[X] Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes (as needed)

CATEGORY 3

What Personal Protection Equipment (PPE) You Shall Wear:
[X] Cotton Underwear
[X] Short Sleeved "T" Shirt (Natural Fiber)
[X] Arc Rated Long Sleeved Shirt and Long Pants
[X] Arc Rated Coveralls (Over the above)
[X] Arc Rated (25 cal) Arc Flash Suite Jacket
[X] Arc Rated (25 cal) Arc Flash Suit Pants
[X] Arc Rated (25cal) Arc Flash Suite Hood
[X] Hard Hat
[X] Safety Glasses or Goggles
[X] Hearing Protection
[X] Arc Rated Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes

CATEGORY 4

What Personal Protection Equipment (PPE) You Shall Wear:
[X] Cotton Underwear
[X] Short Sleeved "T" Shirt (Natural Fiber)
[X] Arc Rated Long Sleeved Shirt and Long Pants
[X] Arc Rated Coveralls (Over the above)
[X] Arc Rated (40 cal) Arc Flash Suite Jacket
[X] Arc Rated (40 cal) Arc Flash Suit Pants
[X] Arc Rated (40 cal) Arc Flash Suite Hood
[X] Hard Hat
[X] Safety Glasses or Goggles
[X] Hearing Protection
[X] Arc Rated Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes

~~Category "0"~~

- Deletion of ***CATEGORY "0"***

  ~ NFPA 70E deleted CAT–0 in 2018 ~

Implies that cotton clothing is not required or is a requirement.

It does not mean there is **NO Hazard!**

~ NFPA 70E ~

working with

Changes

Table 130.5 (c)

PPE is Required

Operation of a Circuit Breaker (CB) or Switch the FIRST TIME after Installation or Maintenance in the equipment.

Likelihood of Occurrence – **YES**

PPE is Required

2021

2024 Changes ~ 70E

110.2(B) Exception No. 2. This new exception permits the operation of an energized disconnecting means or isolating element to achieve an electrically safe work condition (ESWC) or to return equipment to service that has been placed in an ESWC. The equipment supplying the disconnecting means or isolating element shall not be required to be placed in an ESWC, **provided** a risk assessment is performed and there is no unacceptable risk identified.

NFPA 70E Qualified

110.4(A)(1) Qualified Person. The word “special” was changed to “applicable” to make it clear that qualified persons need only be familiar with the techniques they need to use. (b) A person “shall” be qualified for certain equipment and tasks to be performed. The word “can” was changed to “shall” to address the use of the mandatory language.

OSHA
Qualified Person

General Industry 1910

- One who has received training in **and** has demonstrated skills and knowledge in the construction and operation of electric equipment and installations, and the hazards involved.

Batteries and Battery Room

Article 320

OSHA: 1910.333 (a)(1):

Live parts operating at 50 volts and above MUST be de-energized.

OSHA sets the Hazard Voltage threshold at 50 volts (AC or DC).

NFPA 70E:

Chapter 1, Article 130.1: Sets the Hazardous threshold at 50 volts.

Chapter 3, Article 320.3 A (1): Allows an increase of threshold voltage to 100 volts

- **110.3 Job Safety Planning.** A new item, "An emergency response plan," was added to the list of required information for the job safety planning.

- **110.4(A)(1) Qualified Person.** The word "special" was changed to "applicable" to make it clear that qualified persons need only be familiar with techniques they need to use. (b) A person "shall" be qualified for certain equipment and tasks to be performed. The word "can" was changed to "shall" to address use of the mandatory language.
- **Scope:** Was added to each article.
- **Electric:** Was placed in front of the word SHOCK.
- **Protector:** The word Leather was DELETED to permit the use of Protector other than Leather. "A glove or mitten to be worn over a Rubber Insulated Glove.
- OSHA - Requires a Voltage-rated Glove for the Hazard you are exposed to.

Protector: The word Leather was DELETED to permit the use of Protector other than Leather. “A glove or mitten to be worn over a Rubber Insulated Glove.

Table 130.7(C)(15)(b) Arc Flash PPE Categories for DC Systems. A major revision was made.

The upper part of the table that was for voltages from 100V to 250V DC was deleted. The new parameters for the table and arc flash PPE categories are greater than 150V and less than 600V.

Recent test data indicates the probability of sustaining an arc for 125V DC nominal systems is minimal for fault currents less than 17,000A.

Electrical Safety Considerations

- OSHA regulations
  - They are the Law and are Enforceable
  - OSHA: 1910.333 (a)(1):

    Live parts operating at 50 volts and above MUST be de-energized!
  - OSHA sets the Hazard Voltage threshold at 50 volts (AC or DC).

- NFPA 70E:
  - NOT law, safety requirements must comply with OSHA Regulations
  - Chapter 1, Article 130.1: Sets the Hazardous threshold at 50 volts.
  - Chapter 3, Article 320.3 A (1): Allows an increase of voltage to 100 volts

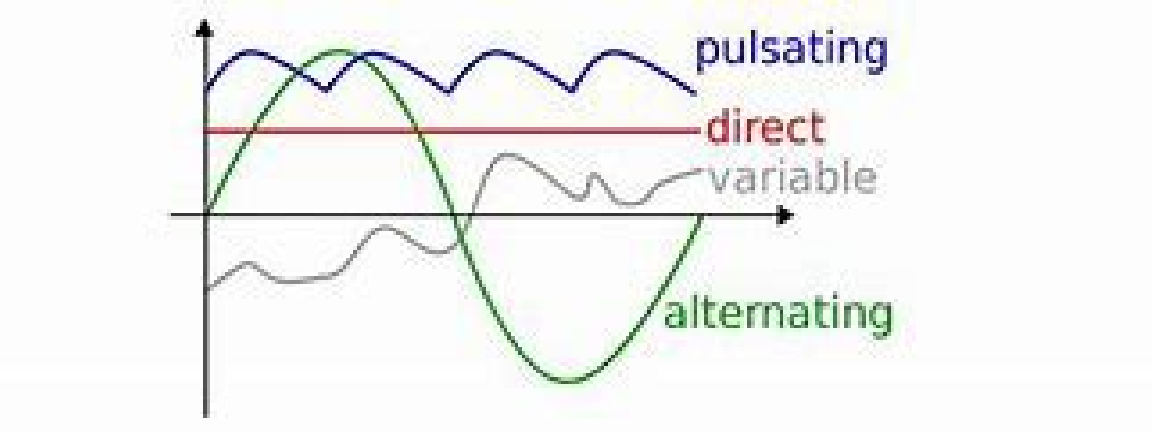
Alternating Current vs. Direct Current

- Alternating Current: AC

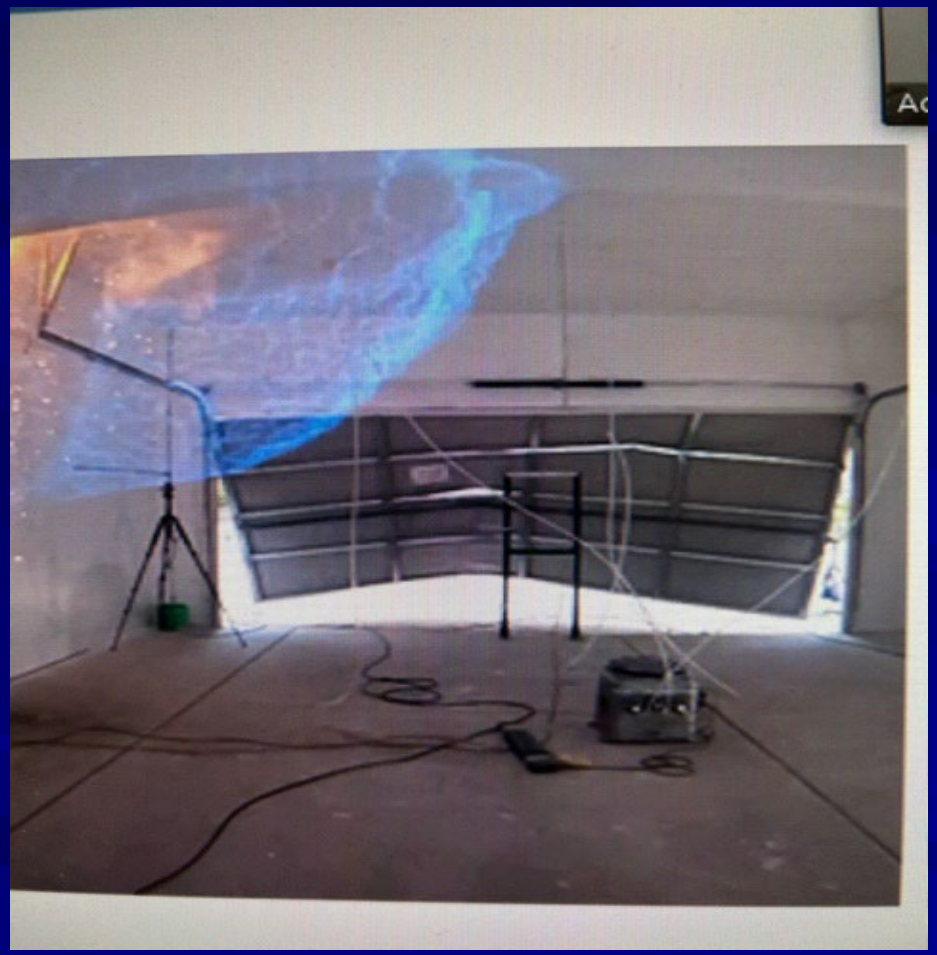
  Refers to a periodic current with Successive Half-Waves

- Direct Current: DC

  Unidirectional, the term designates a practically Non-Pulsating Current



Chemistry



Lithium Battery Concerns

- Gases from the system
- Thermal Runaway
- Cell Propagation
- Extinguishing (water is for cooling only)

- Injuries in NY from e-mobility devices 2022 – 147
- Compared to 2019 – 13 **1100 % increase**

  - Do’s
  - Don'ts

Battery room

Substation Boston MA.

March 20, 1923

Stuart Street, Boston MA.

November 9, 1938

Plate removal operations are an attempt to mitigate the hazard of lead poisoning exposure.

HOW ARE YOU GOING TO BUILD YOUR

Electrical Safety Plan

Thank you for Attending

kenandrea@mescconsultinggroup.com