Electrical Association

2024
NFPA 70E Safety Training

BY THE ELECTRICAL ASSOCIATION

BY SUCCESSFULLY COMPLETING THIS CLASS, YOU WILL EARN 4 HOURS OF NON CODE - CONTINUING EDUCATION TOWARD LICENSE RENEWAL

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Presentation material is adapted from the 2024 NFPA 70E. Actual standard articles in their entirety are required to maintain compliance.

Learning Outcomes NFPA 70E Safety Training

Upon completion of this training session, the participant should be able to:

1. Understand the relationship between OSHA and the NEC in development of the 70E.
2. Describe the employer's and the employee's responsibilities in following safety related work practices and procedures.
3. Understand when it is permissible to work on energized circuits.
4. Understand OSHA requirements for GFCI protection of equipment
5. Execute correctly the Lock/Tag/Test process of electrical equipment

Learning Outcomes NFPA 70E Safety Training

(continued)

6. Identify:
   a limited approach boundary
   a restricted approach boundary
   an arch flash boundary
7. Complete a shock risk and arc flash risk assessment
8. Interpret OSHA 70E equipment labels
9. Make correct choices of PPE based on OSHA 70E standards

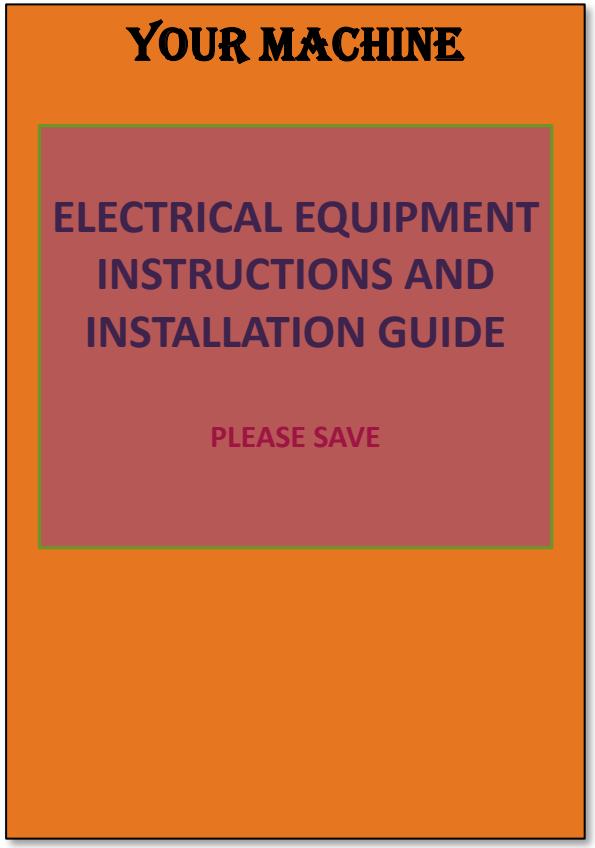
NFPA 70E 2024

NFPA 70E 2024 is a Standard.

This is a document that will indicate requirements which is in a form suitable for mandatory reference by another standard.

MNOSHA encourages employers to use 70E to comply with OSHA standards.

Consider Conditions of Maintenance & Testing



- ***NFPA 70B Recommended Practice for Electrical Equipment Maintenance 2023***
- ***MTS Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems*** (2023 Edition by ANSI/NETA MTS)

Definitions

Arc Flash

- Extreme light
- Extreme heat

Arc Blast

- Pressure from expansion of copper
- Pressure from explosion and sound waves
- Shrapnel
- Molten metal

Definitions

Electrical Safety Program

A documented system to address safety principles, policies, procedures, and processes that directs the activities for risk associated with electrical hazards.

Electrically Safe Work Condition

The electrical component has been disconnected from the power source, locked/tagged and tested to verify no voltage, and if necessary, temporarily grounded.

Definitions

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Arc Flash Boundary

When an arc flash hazard exists, an approach limit from an arc source at which the incident energy equals 1.2 calories per square centimeter.

Limited Approach Boundary

The distance from an exposed energized part within which a shock hazard exists.

Restricted Approach Boundary

The distance from an exposed energized part where there is an increased likelihood of shock.

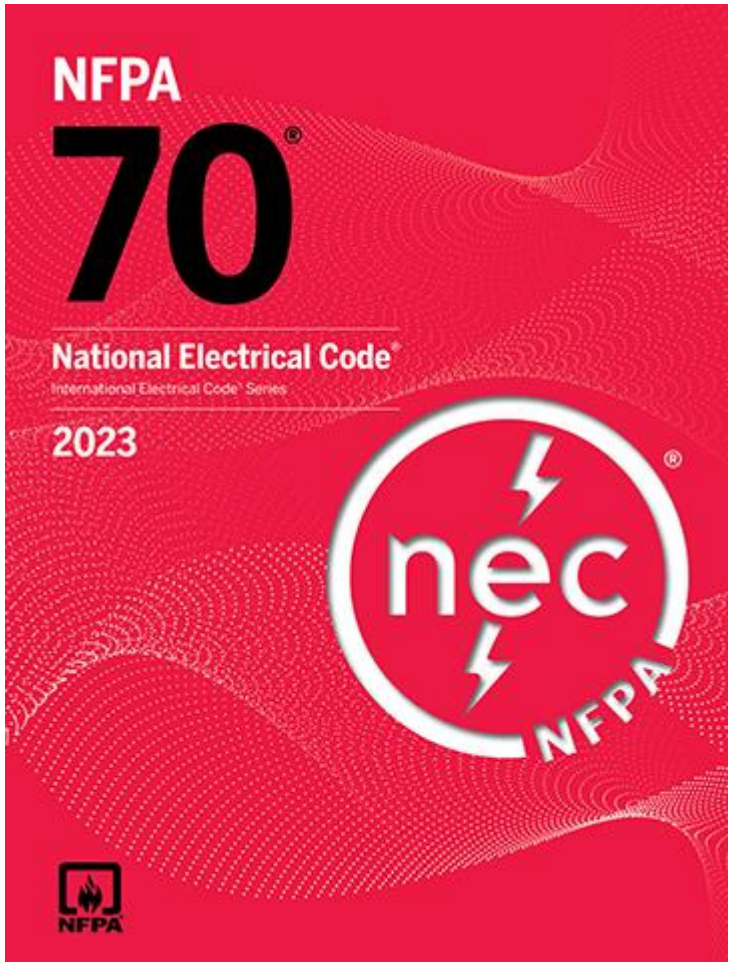
Definitions

Qualified Person

OSHA 1910.399 CFR 29 Subpart S:
Qualified person. 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.

NFPA 70E 2024:
Qualified person. One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.

The National Electrical Code 2023



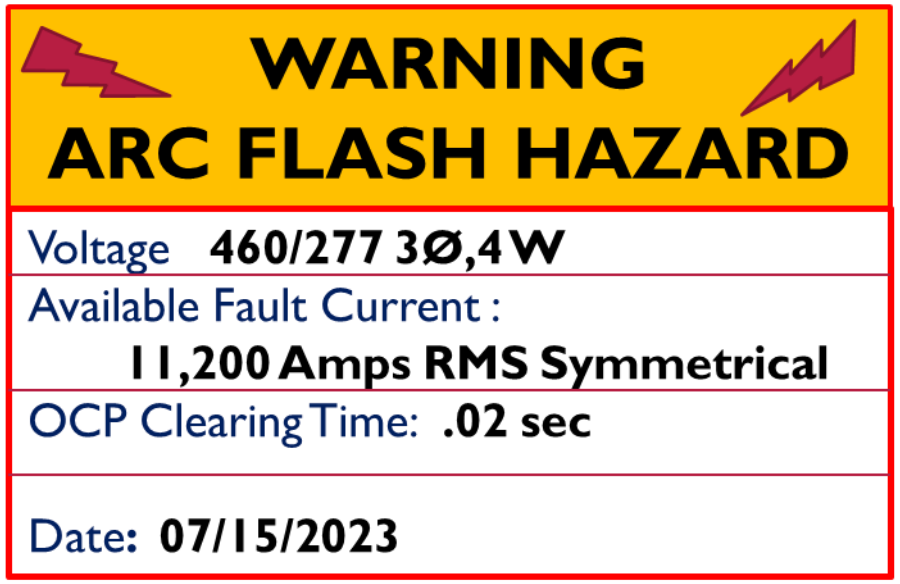
This is a standard that is an extensive compilation of provisions covering broad subject matter that is suitable for adoption into law independently of other codes and standards.

It is created in the interest of **life** and **property** protection—NOT necessarily for protection of the electrical worker.

2023 NEC® 110.16(B)

(B) Service Equipment and Feeder Supplied Equipment.

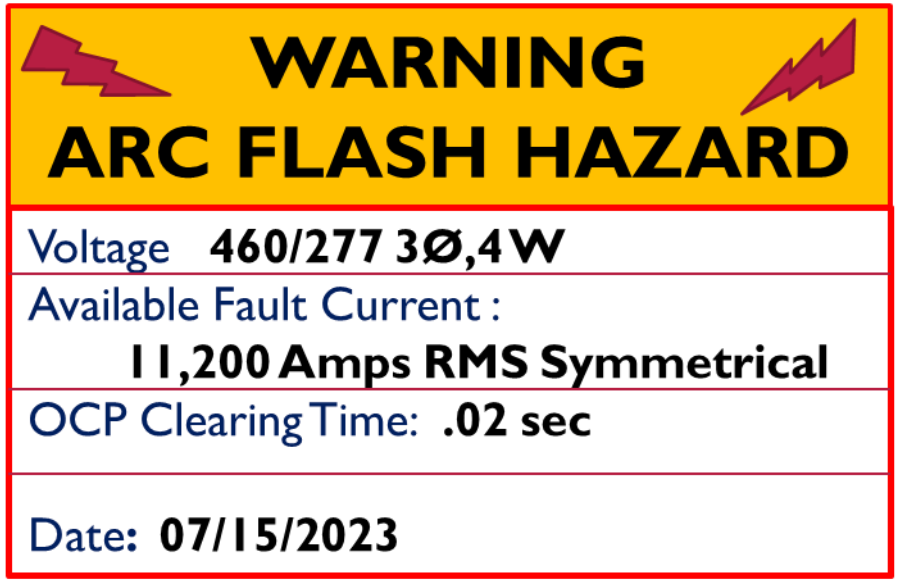
In other than dwelling units, in addition to the requirements in 110.16(A), a permanent arc flash label shall be field or factory applied to service equipment and feeder supplied equipment rated 1000 amperes or more. The arc flash label shall be in accordance with applicable industry practice and include the date the label was applied. *



* Shaded text indicates a change in the 2023 NEC

NEC 2020® 110.16 Arc Flash Hazard Warning

- Article 408.6 Requires that the available short circuit current level be posted.
- The OCP Fault Clearing Time is not required* but suggested to be included on the warning label based on 110.16(B) IN No. 2



* Shaded text indicates a change in the 2023 NEC

Top 10 OSHA Violations FY 2021

OSHA Standard FY 2021	FY 2019
1. Fall Protection: General Requirements (1926.501)	1
2. Hazard Communication (1910.1200)	5
3. Respiratory Protection (1910.134)	2
4. Ladders (1910.1053)	3
5. Scaffolding, construction (1926.451)	4
6. Lockout /Tagout	6
7. Powered Industrial Trucks (1910.178)	9
8. Fall Protection: Training Requirements (1926.503)	7
9. Personal Protective Equipment (1926.102)	8
10. Machinery and Machine Guarding (1910.212)	10

FY 2022 OSHA Violations

#6 Lockout/Tagout (1910.147)	2,175 Cited Violations

70E

- Establish Electrically Safe Work Conditions (ESWC)
- Plan and anticipate safe work
- Identify and reduce risks
- Train qualified employees
- Use proper tools and clothing

105.3

Addresses electrical safety work practices as well as procedures for workers exposed to electrical hazards

(A) Employer

- Must establish, execute, and document safety-related work practices and procedures required by the standard (70E)
- Must provide employees with training in the employer's safety-related work practices and procedures.

(B) Employee

- Shall comply with the safety-related work practices and procedures provided by the employer.

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.2 Electrically Safe working Condition

- **(A) Policy. (New 2023)**

An employer shall establish, document, and implement an electrically safe work condition policy that does both of the following:

(1) Requires **hazard elimination** to be the **first priority** in the implementation of safety-related work practices

(2) Complies with 110.2(B) “When Required” (to establish an ESWC)

110.2 Electrically Safe working Condition

- **(B) When Required. (New 2023)**
- Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition **before an employee performs work** if any of the following conditions exist:
- (1) The employee is within the limited approach boundary.
- (2) The employee interacts with equipment where conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists”

110.2 Electrically Safe working Condition

- **(B) When Required.**
- **Exception # 1 Normal Operation of Electrical equipment**
- *Normal operation of electric equipment* can be done *where a normal operating condition exists. A normal operating condition exists when **all** of the following conditions are satisfied:*
- (1)The equipment is properly installed.
- (2)The equipment is properly maintained.
- (3)The equipment is rated for the available fault current.
- (4)The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
- (5)The equipment doors are closed and secured.
- (6)All equipment covers are in place and secured.
- (7)There is no evidence of impending failure.

110.2 Electrically Safe working Condition

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Exception No. 3

Energized electrical work can be done where the employer can demonstrate that the task to be performed is infeasible in a de-energized state because of equipment design or operational limitations.

Example: performing diagnostics and testing (e.g., start-up or troubleshooting) of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

110.2 Electrically Safe working Condition

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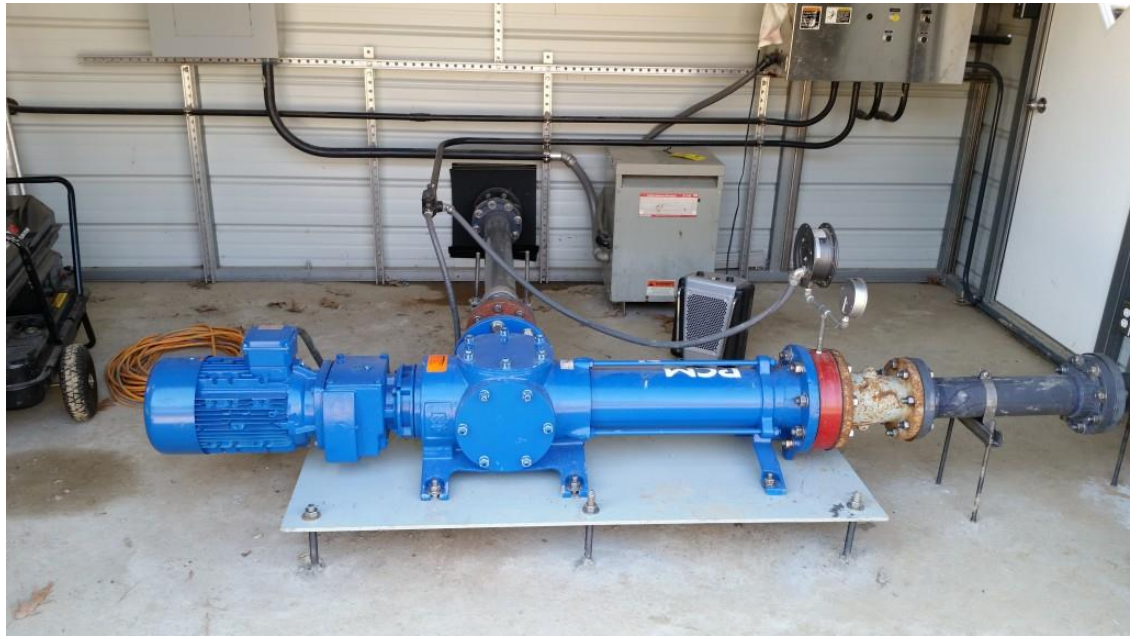
Exception No. 4

Energized electrical work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

E.g., interruption of life support equipment, deactivation of emergency alarm systems, and shutdown of ventilation systems for hazardous locations.



110.2 Electrically Safe working Condition

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Exception No. 5

Equipment operating at less than 50 volts may be worked on without de-energizing if it determined the capacity of the source does not expose workers to electric arcs.

110.3 Electrical Safety Program

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(A) General

Employers need a program to provide safe usage of electrical systems…
to direct activity appropriate to the risk associated with electrical hazards. The plan needs to be implemented as part of occupational safety and health management system, when one exists. It must be documented.

(B) Inspection

The safety program will include verification that installed or modified equipment has been inspected to comply with installation codes

(C) Conditions of Maintenance

The electrical safety plan shall include elements that consider maintenance of electrical systems

(D) Awareness and Self Discipline

Plan to include the awareness and self discipline for self protection.

110.3 Electrical Safety Program (continued)

(E) Safety Program Principles

Have a set plan or process to provide safe operations based on safety principles before the work is started.

(F) Electrical Safety Program Controls

Needed to explain how the safety program is controlled and monitored

(G) Program Procedures

Shall identify the procedures to be followed **before** the work is started

(H) Risk Assessment Procedure

(1) Identify hazards, assess risk, implement risk control

(2) Human error—What are the consequences?

(3) Hierarchy of risks *(next slide)*

Hierarchy of Risks

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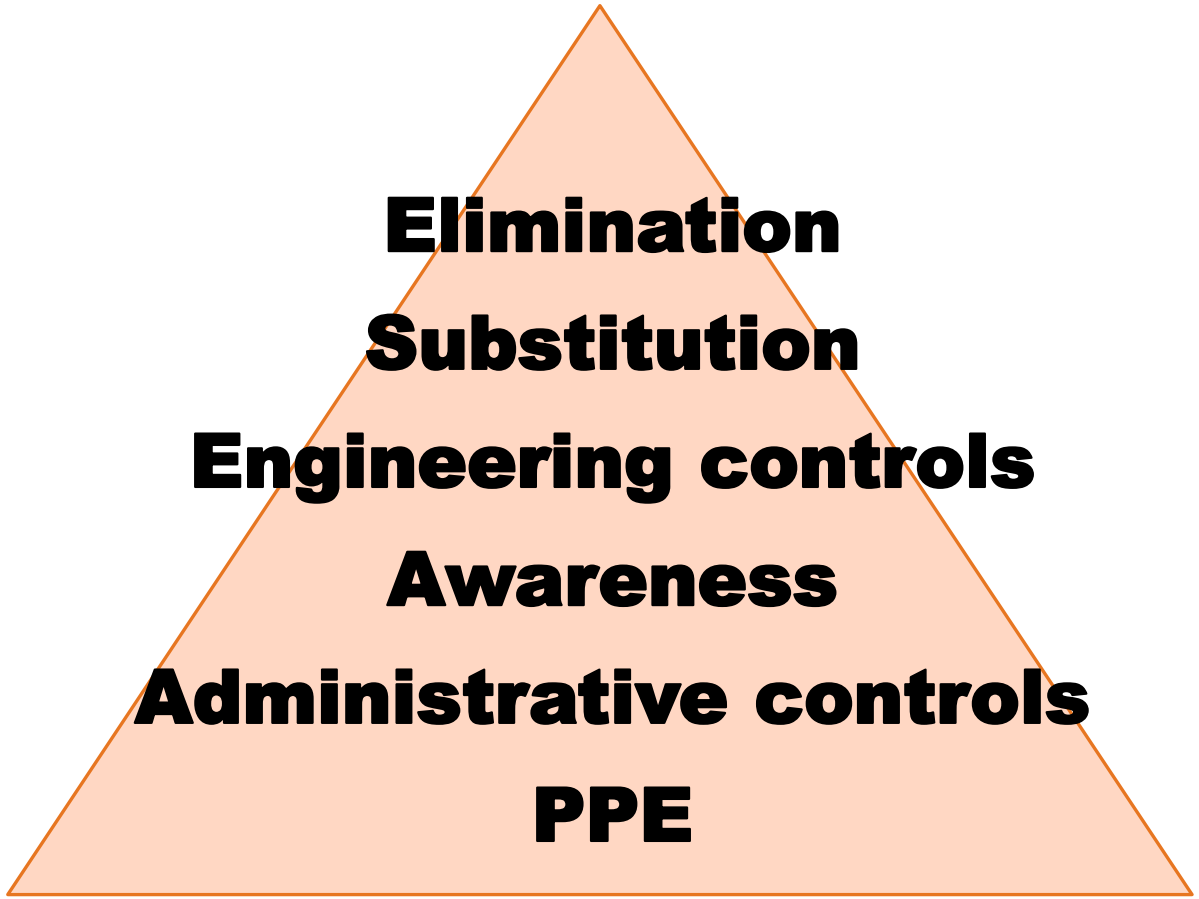
Highest Priority



Last Priority

Hierarchy of Risks

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Table F.3 The Hierarchy of Risk Control Methods

Risk Control Method	Examples
(1) Elimination	Conductors and circuit parts in an electrically safe working condition
(2) Substitution	Reduce energy by replacing 120 V control circuitry with 24 Vac or Vdc control circuitry
(3) Engineering controls	Guard energized electrical conductors and circuit parts to reduce the likelihood of electrical contact or arcing faults
(4) Awareness	Signs alerting of the potential presence of hazards
(5) Administrative controls	Procedures and job planning tools
(6) PPE	Shock and arc flash PPE

110.3 Electrical Safety Program (continued)

(I) Job Safety Planning and Job Briefing
Before the job commences, conduct job briefing. Include hazards, PPE, assessment, work procedures, tools and equipment, any special requirements - change of scope and an emergency response plan (new)

J. Incident Investigation
Investigate all incidents as in - jury or death and also “near miss” incidents

K. Lockout Tagout Program

L. Auditing

110.4 Training Requirements

(A) Employees who are exposed to electrical hazards, when the risk to those hazards is not reduced to a safe level, need to be trained to understand the hazards associated with electrical energy. They must be trained in safety related work practices needed to avoid the hazards.

110.4 Training Requirements

Three Primary Focuses

- **(A) Electrical Safety Training**
- **(B) Lockout/Tagout Procedure Training.**
- **(C) Emergency Response Training.**

110.4(A)(1) Training Requirements

QUALIFIED PERSON

(1) A **qualified person** shall be trained and knowledgeable in the construction and operation of equipment or specific work methods. They shall be trained to identify and avoid the hazards associated with the equipment.

(a) These qualified individuals shall be familiar with the precautionary techniques...

(b) They may be qualified on some equipment and unqualified for other equipment

(c) Persons within the **limited approach** boundary shall also be trained to:

(1) distinguish exposed live conductors from other electrical equipment

(2) ascertain nominal voltages

(3) determine approach distance requirements

(4) perform the following tasks:

110.4(A)(1) Training Requirements(cont.)

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a. Perform job safety planning
b. Identify electrical hazards
c. Assess the associated risk
d. Select the appropriate risk control methods as defined in “risk assessment procedures” 110.1(G)

(d) A person **being trained as a qualified person** and can demonstrate the needed skills can be a qualified person for specific tasks **while under supervision**

(e) Employees shall be trained to select the proper test instruments and demonstrate how to use it to verify an ESWC. They must understand the limitations of the test equipment

(f) At least annually, the employer must verify that the employee is complying with the safety-related work practices

110.4(A)(2) Training Requirements

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UNQUALIFIED PERSON

Unqualified persons shall be trained in, and be familiar with, any electrical safety-related practices necessary for their safety.

- **Do not cross** the **limited approach** boundary **unless supervised** by a qualified person
- **NOT** allowed to cross the restricted approach boundary

They are **NOT** qualified to work on systems over 50 volts to ground

110.4(A)(3) Training Requirements

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Additional Training and Retraining:

At intervals not exceeding 3 years, an employee must receive additional training or retraining if any of the following conditions exists

1) The employee is not complying with safe work practices
2) New technologies are introduced
3) Tasks that are performed less than once per year-- **require retraining** before performing tasks
4) Safety practices were not in normal scope of work
5) The employee's job duty changes

110.4(A)(4) Types of Training

Training can be in the classroom or on the job or both.

- NFPA does not specify who is qualified to provide the training.
- The employer is to determine the suitability and knowledge of the instructor.

OSHA and NFPA consider instructor-led classroom and on-the-job training to be most effective; other types of training may also be used.

110.4(A)(5) Training Documentation

Employer shall document that the employee has received training:

1) When the employee has demonstrated proficiency in the work practices involved.

2) The records shall be maintained for the duration of employee's employment

3) The documents must contain the employees name, date, content of training.

110.4(B) Lockout/Tagout Procedure Training

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1) **Initial training:** Each person involved with LOTO procedures must be trained and be knowledgeable regrading their role in the execution of the procedure
2) **Retaining:** Retraining is to be **at least every three years** OR
   - The basis for additional training referenced in 110.4(A)(3)
3) **Documentation:** The **EMPLOYER** shall document that each employee has received training and
   - has demonstrated proficiency in performing the work standard
   - record the date and name of employee and the content of the training

110.4(C)(1) Emergency Response Training

- **(1) Contact Release.**

- Employees exposed to electric shock hazards and those responsible for the safe release of victims from contact with energized electrical conductors or circuit parts shall be trained in methods of safe release. <u>Refresher training shall occur annually.</u>

110.4(C)(2) Emergency Response Training

- **(2) First Aid, Emergency Response And Resuscitation**
- (a) Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures.
- (b) Employees responsible for responding to medical emergencies shall be trained in cardiopulmonary resuscitation (CPR).
- (c) Employees responsible for responding to medical emergencies shall be trained in the use of an automated external defibrillator (AED) if an employer's emergency response plan includes the use of this device.
- (d) Training shall occur at a frequency that satisfies the requirements of the certifying body

110.4(C)(3+4) Emergency Response Training

- **(3) Training Verification**
- Employers must verify at least annually that employee training required by 110.4(C) is current.

- **(4)Documentation**
- The employers must document that the training required by 110.4(C) has occurred

110.5(A) Host and Contract Employer

- **(A) Host Employer Responsibilities**
- The host employer shall inform any contract employer that they follow OSHA and 70E and there are electrical hazards in the scope of work
- The host employer will report any violations of the 70E standard to the contract employer.

110.5(B) Host and Contract Employer

- **(B) Contract Employer Responsibilities**
- A contract employer is responsible to inform his employees of the host's policies, and that all must follow the procedures.
- Any additional hazards encountered must be communicated to the host employer.
- Any corrective action the contract employee took to remedy the unsafe condition be reported to the host employer.

110.5(C) Host and Contract Employer

(C) Documentation

Where the host employer has knowledge of hazards covered by this standard that are related to the contract employer's work, there shall be a documented meeting between the host employer and the contract employer.

110.6 Test Instruments & Equipment

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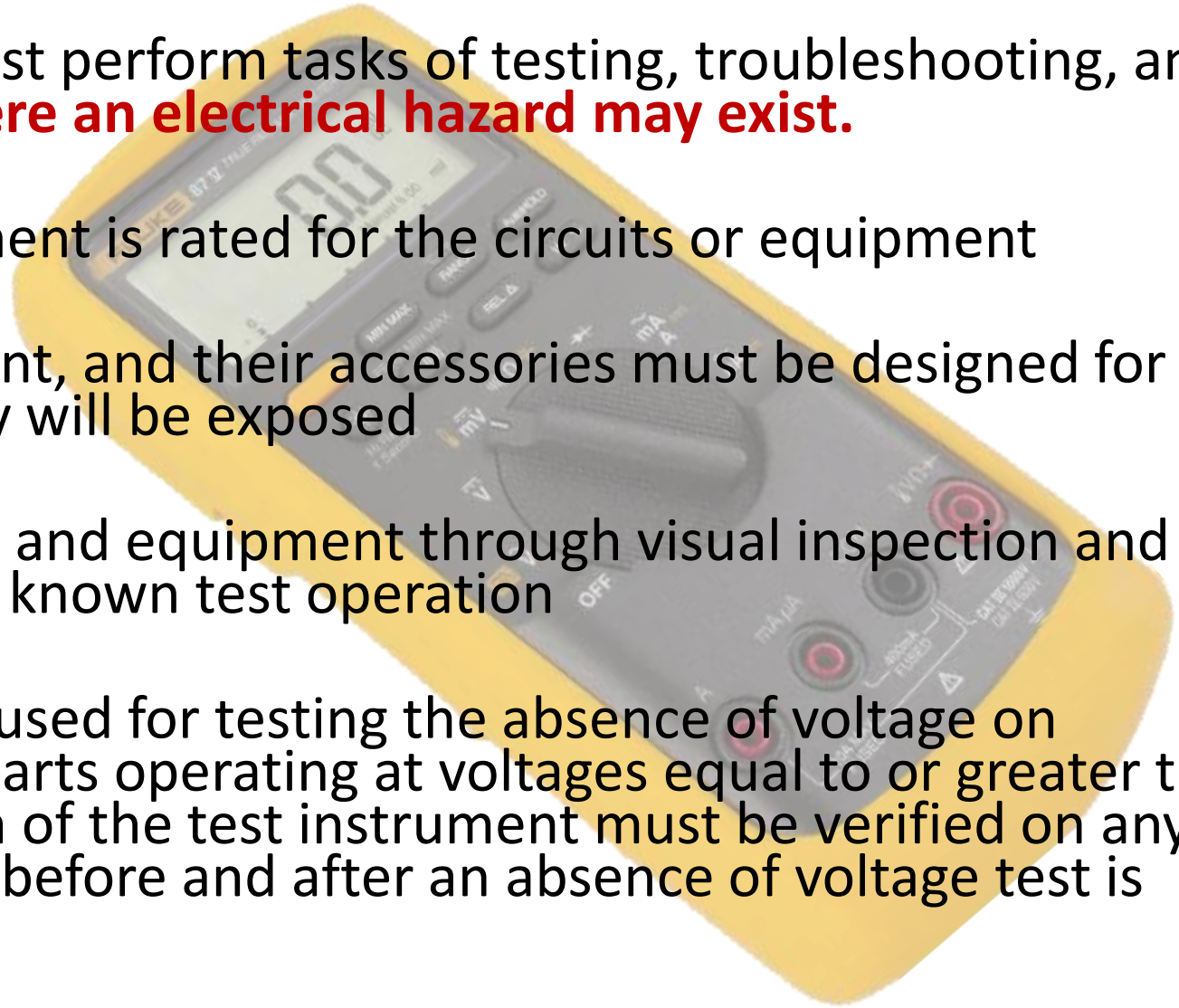
(A) Only **qualified persons** must perform tasks of testing, troubleshooting, and voltage measurement **where an electrical hazard may exist.**

(B) Make sure the test equipment is rated for the circuits or equipment

(C) Test instruments, equipment, and their accessories must be designed for the environment to which they will be exposed

(D) Verify safe test instruments and equipment through visual inspection and verify proper operation with known test operation

(E) When test instruments are used for testing the absence of voltage on conductors or circuit parts operating at voltages equal to or greater than 50 volts, the operation of the test instrument must be verified on any known voltage source before and after an absence of voltage test is performed.



110.7 Cord-and-Plug-Connected Equipment

(A) Handle and store equipment appropriately

(B) Grounding type equipment
All metal surfaces need to be grounded

(C) Inspect cord-and-plug-connected equipment
Broken/damaged missing parts?

(D) Conductive work locations (GFCI protection)

(E) Attachment plugs
Strain relief grips required w/all prongs present

(F) Use per manufacturer's instructions

110.8 GFCI Protection

- GFCI receptacles or GFCI cord sets are to be used as per NEC® or other local standards
- Maintain and test GFCI protection
- Maintenance and construction require the use of GFCI for 15-20-30 A, 125 V circuits. If other than these base requirements, the circuits shall be GFCI protected or on circuits greater than 120 volts, the assured equipment grounding conductor program must be used.

110.9 Overcurrent Protection Modification

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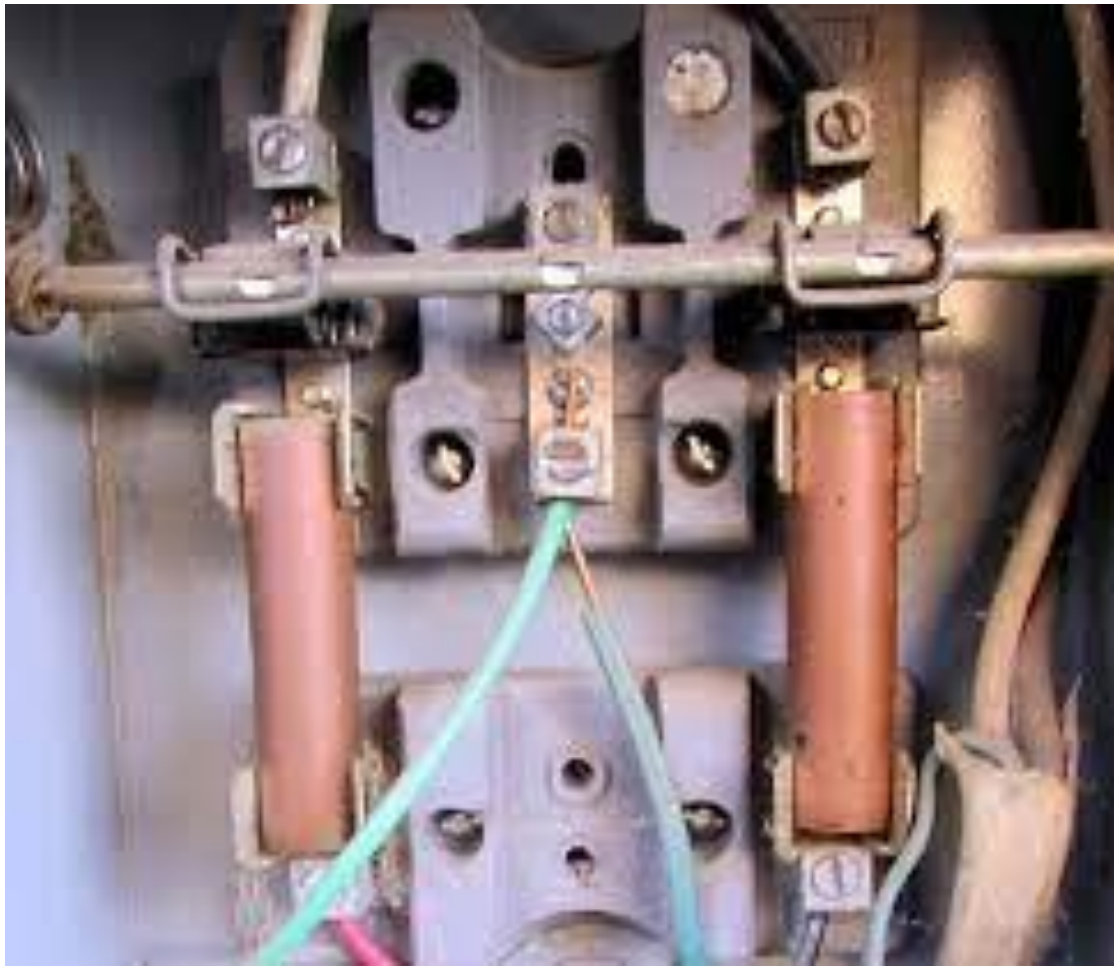
Overcurrent protection of circuits and conductors must not be modified, even on a temporary basis, beyond what is permitted by applicable portions of electrical codes and standards dealing with overcurrent protection



Establishing an Electrically Safe Work Condition

NFPA 70E 2024 - ARTICLE 120

120.2 Lockout/Tagout Program

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(A) General

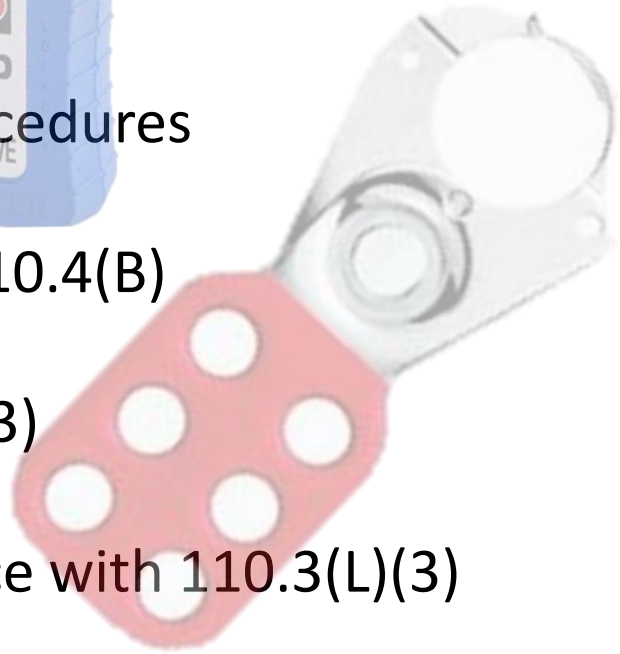
Each employer will have a program for LOTO. The program must :

(1) Be applicable to the experience and training of the workers and conditions in the workplace

(2) Meet the requirements of 120.2 through 120.6

(3) Apply to fixed, permanently installed equipment, temporarily installed equipment, and portable equipment

120.1 Lockout/Tagout Program



(B) Employer Responsibilities.

The employer is responsible for the following:

(1) Providing the equipment necessary to execute lockout/tagout procedures

(2) Providing lockout/tagout training to workers in accordance with 110.4(B)

(3) Auditing the lockout/tagout program in accordance with 110.3(L)(3)

(4) Auditing execution of the lockout/tagout procedures in accordance with 110.3(L)(3)

Personal LOTO

120.3 LOTO Principles

If disconnected but not locked out, circuits are not considered electrically safe

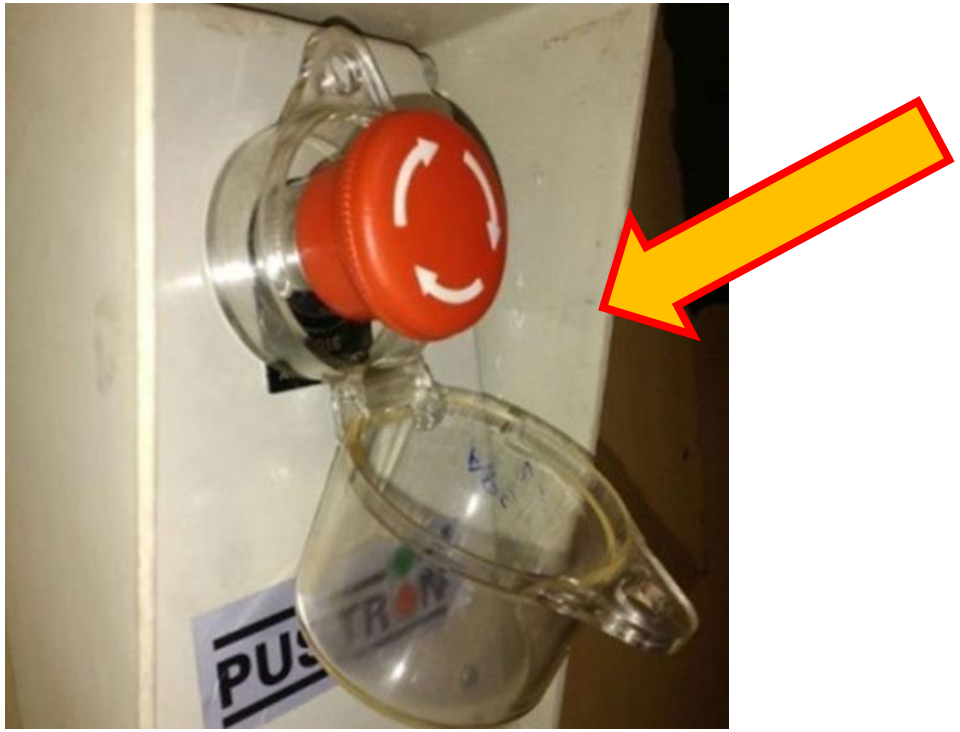
(A) Each person locks out the equipment they are working on

(B) Apply LOTO procedures based on current conditions and up-to-date electrical drawings

(C) All energy systems (including stored energy) must be controlled

(D) Test for interlock and interconnected systems to avoid live power

Control devices –Not Approved Lockout



(E) Do not use control devices to provide lock out function –
Use approved disconnecting devices

Labels for Power Sources – All Sources

120.3 LOTO Principles

(F) Identification of LOTO devices are to be readily identifiable

(G) Coordination

- Have a workplace plan - who does what - coordinated procedures
- Lock with controlled keys (or combination) and identification as to whose lock is on the equipment

(H) Forms of LOTO. **Simple LOTO** and **Complex LOTO** need procedures

- Simple – One employee locking out a single set of conductors
- Complex – Multiple energy sources, multiple crews, multiple crafts, multiple locations, multiple disconnecting means, special circumstances

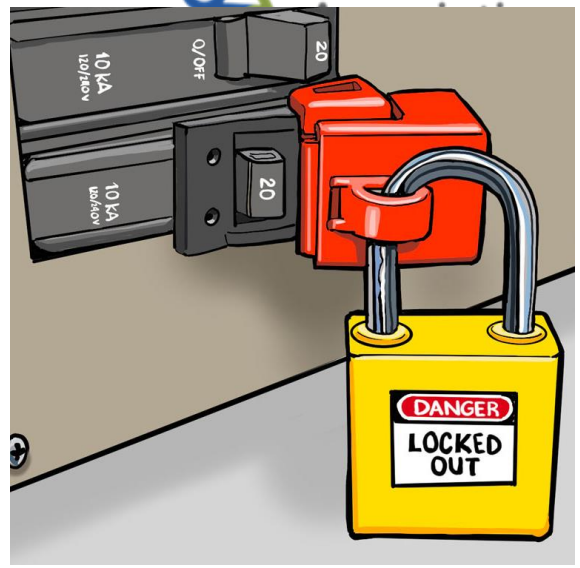
120.4 Lockout / Tagout Equipment

- Locks can be either keyed or combination
- Locks shall include a notification of who installed the lock
- The LO device can be just a lock if it has identification on it
- The lock must be substantial enough to prevent easy removal
- Where a tag is attached, it will state that it is not permitted to remove or circumvent the locked device
- The key or combination shall be the responsibility of the installer or person in charge

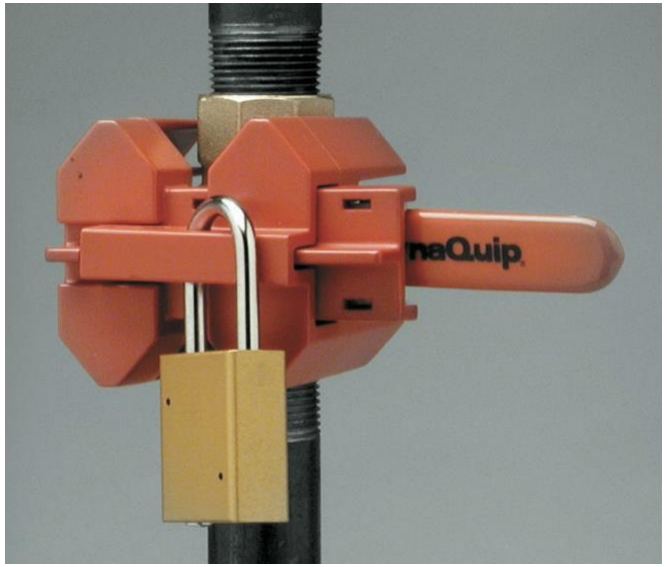
LOTO Devices 120.4(B)

PLUG & CONNECTOR LOCKOUT DEVICES

BREAKER LOCKOUT DEVICE



VALVE LOCKOUT DEVICES



PLUG LOCKOUT DEVICE

120.6 LOTO: Lock-Tag-Test

ELECTRICALLY SAFE WORK CONDITIONS—ESTABLISHED BY THESE 8 STEPS

1. Determine all sources of electrical supply to equipment
2. Safely interrupt load current, then open positive disconnecting devices
3. If possible, verify that a positive disconnect has occurred
4. Release stored electrical energy (See Annex R for capacitor discharge information)
5. Release or block mechanical energy
6. Apply lock-out/ tag-out devices
7. Test for voltage on all known test points with verified equipment
8. Where possible, ground the phase conductors (ground bails/clamps)

120.6(7) Voltage Testing

Would use of this non-contact voltage sensor device be a 70E-approved method of testing for voltage at this 208-volt fuse block?

120.6(7) LOTO Testing for Voltage

NO

Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized.

Test each phase conductor or circuit part both phase-to-phase and phase-to-ground.

Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

120.6(7) LOTO Testing for Voltage

Yes, if device is rated over 1000 volts.

Exception # 2:
On electrical systems over 1000 volts, noncontact capacitive test instruments shall be permitted to be used to test each phase conductor.

Voltage Detector to 1 VAC ± $350

Work Involving Electrical Hazards

NFPA 70E ARTICLE 130

Fault Current and IC Rating

- Flash hazard depends on the amount of fault current and the duration time of arc.
- Current-limiting fuses or fast acting can limit the amount of current and the time of ARC to reduce the incident energy.
- Fault current is determined by the system design, including the transformer supply, type of feeder installed and distance to the fault.

- Available Fault Current
- The largest amount of current capable of being delivered at a point on the system during a short circuit condition.

- Amp Interrupting Capacity
  The highest current at rated voltage that a device is identified to interrupt under standard test conditions.

130.1 Scope

- When energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts are not put into an electrically safe work condition, and work is performed as permitted in accordance with 110.2(B), all of the following requirements apply:

- (1) Only qualified persons can work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
- (2) An energized electrical work permit must be completed as required by 130.2.
- (3) An electric shock risk assessment must be performed required by 130.4.
- (4) An arc flash risk assessment must be performed required by 130.5.

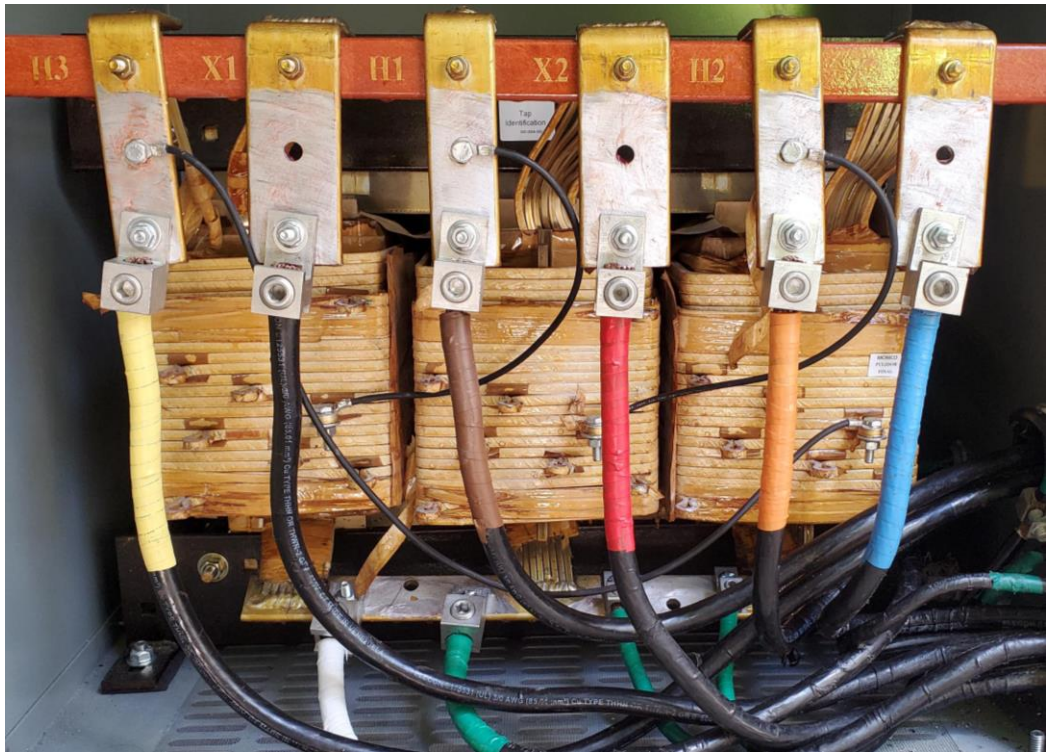
Article 130.2 Energized Electrical Work Permit

(A) When Required.

When work is performed as permitted in accordance with 110.2(B), an energized electrical work permit shall be required and documented under any of the following conditions:

(1) When work is performed within the restricted approach boundary

(2) When the employee interacts with the equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists



Article 130.2(B) Elements of Work Permit.

(B) Elements of Work Permit.

The work permit shall include, but not be limited to, the following items:

(1) Description of the circuit and equipment to be worked on and their location

(2) Description of the work to be performed

(3) Justification for why the work must be performed in an energized condition [see 110.2(B)]

(4) Description of the safe work practices to be employed (see 130.1)

(5) Results of the electric shock risk assessment [see 130.4(A)

Article 130.2(B) Elements of Work Permit:

(B) Elements of Work Permit. (CONTINUED)

(6) Results of the arc flash risk assessment [see 130.5(A)]

(7) Means employed to restrict the access of unqualified persons from the work area [see 130.8(O)]

(8) Evidence of completion of a job briefing, including a discussion of any job-specific hazards [see 110.3(I)]

(9) Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s

Article 130.2(C) Exemptions to Work Permit.

- Electrical work shall be permitted without an energized electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with Chapter 1 under any of the following conditions:

(1) Testing, troubleshooting, or voltage measuring

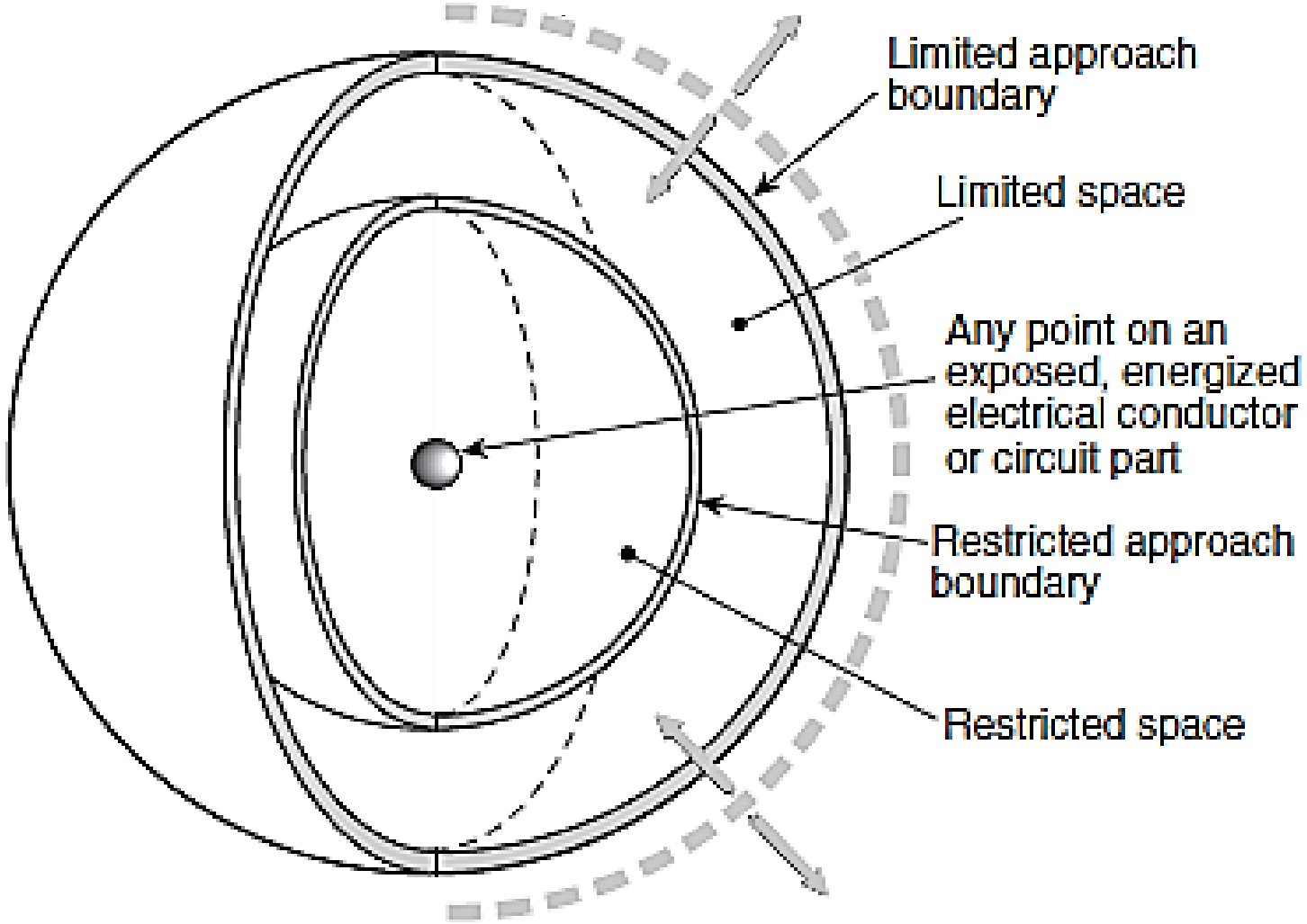
(2) Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed

(3) Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed

(4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed

Approach Boundaries

Approach boundaries determine area where **shock or electrocution risks** may exist.



Approach Boundaries for Shock Protection

Electrical Association

130.4(A) Shock risk assessment shall be performed to:

(1) identify the shock hazard

(2) estimate the cont. likelihood of injury occurrence or health damage

(3) to determine if additional protective measures are required

130.4(B) Estimate of Likelihood and Severity shall consider:

(1) the design of the equipment

(2) equipment condition and condition of maintenance

130.4(C) Additional protective measures

130.4(D) Documentation - required for shock risk assessment

130.4(E) Shock Protection Boundaries

- Table 130.4(E)(a) for AC boundaries
- Table 130.4(E)(b) for DC boundaries

Table 130.4(E)(a) Shock Protection Approach Boundaries for A/C Systems

Electrical Association

Table 130.4(E)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems			
(1)	(2)	(3)	(4)
	Limited Approach Boundary		Restricted Approach Boundary; Includes Inadvertent Movement Adder
Nominal System Voltage Range, Phase to Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	
Less than 50 V	Not specified	Not specified	Not specified
50 V–150 V[d]	10 ft 0 in. (3.0 m)	3 ft 6 in. (1 m)	Avoid contact
151 V–750 V	10 ft 0 in. (3.0 m)	3 ft 6 in. (1 m)	1 ft 0 in. (0.3 m)
751 V–15 kV	10 ft 0 in. (3.0 m)	5 ft 0 in. (1.5 m	2 ft 2 in. (0.7 m)
15.1 kV–36 kV	10 ft 0 in. (3.0 m)	6 ft 0 in. (1.8 m)	2 ft 9 in. (0.8 m)
36.1 kV–46 kV	10 ft 0 in. (3.0 m)	8 ft 0 in. (2.5 m)	2 ft 9 in. (0.8 m)

SHOCK HAZARDS

130.4 Limited/Restricted Approach Boundary

Electrical Association

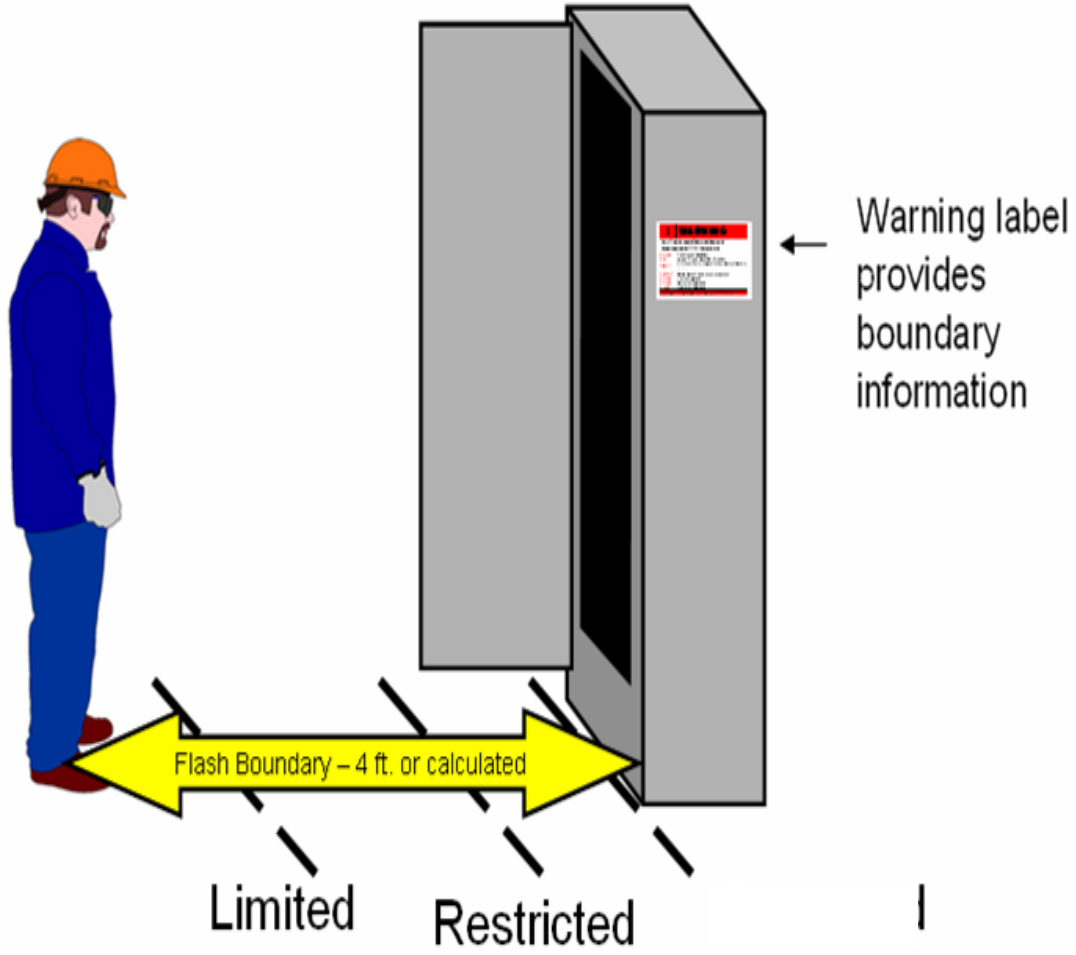
SHOCK BOUNDARY

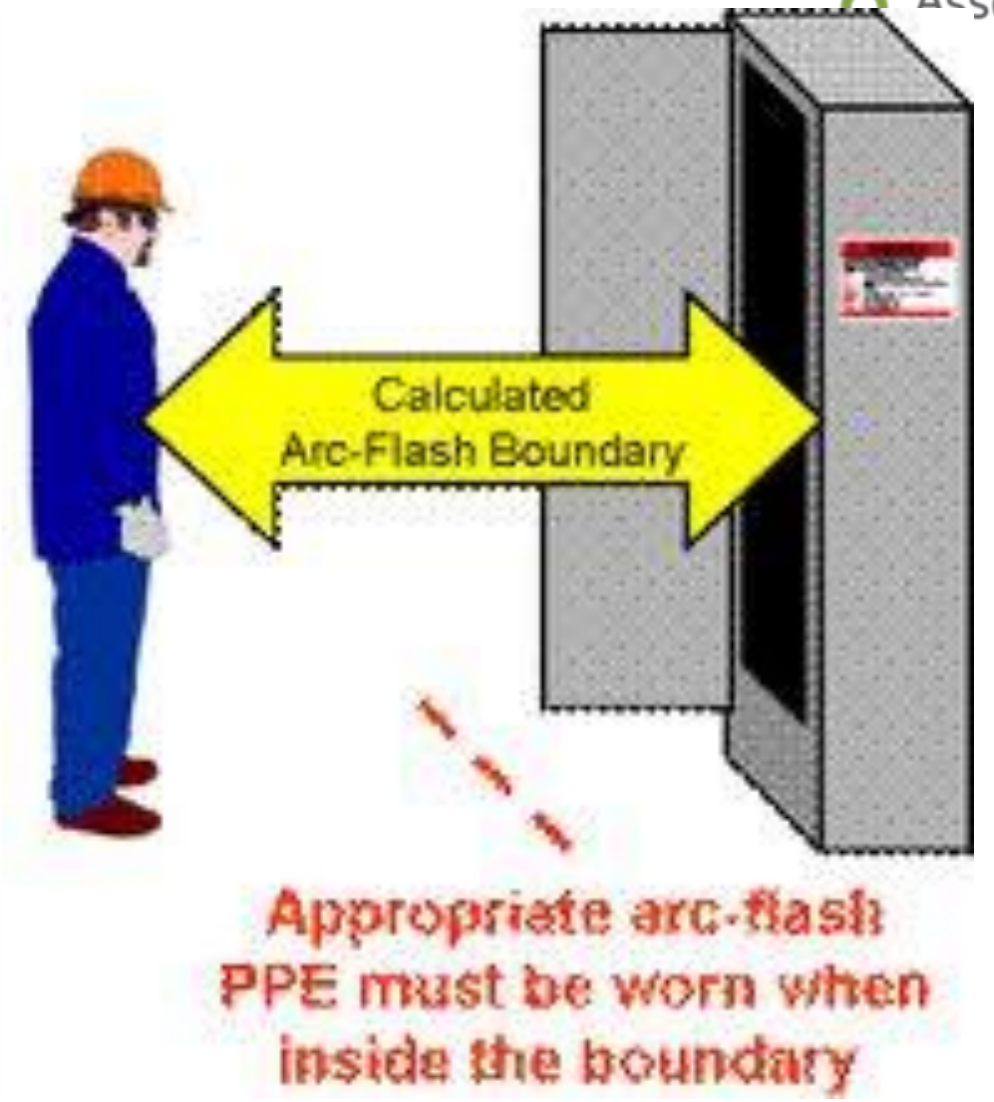
130.4(F)(1) **NO unqualified person** is allowed inside the Limited Approach boundary unless they have been advised of the danger and have proper PPE

130.4(G) **NO unqualified person** is allowed within the Restricted Approach under any circumstance

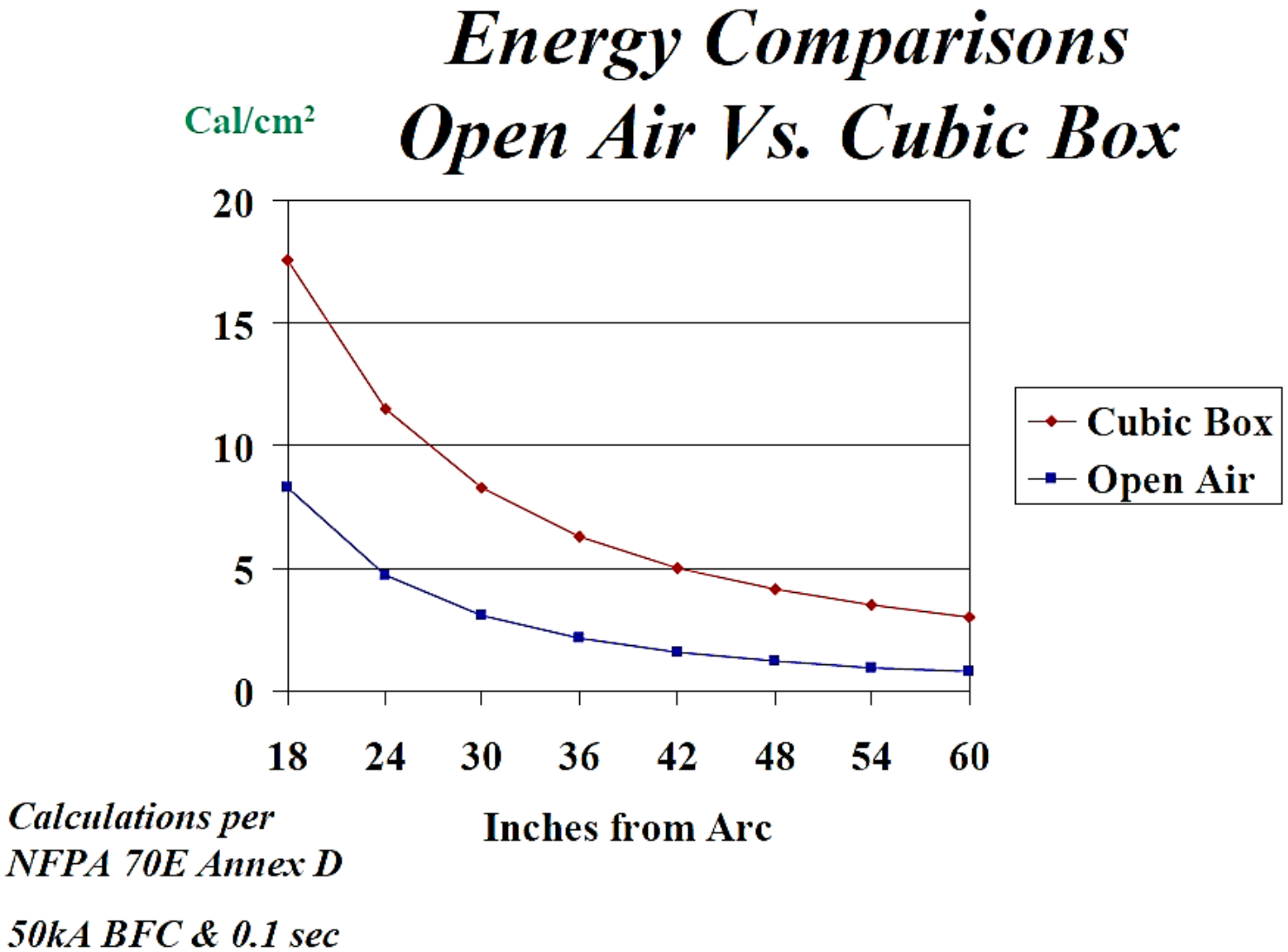
Do not take conductive objects closer than the Restricted Approach unless the voltage is less than 50V or there is adequate insulation

Distances

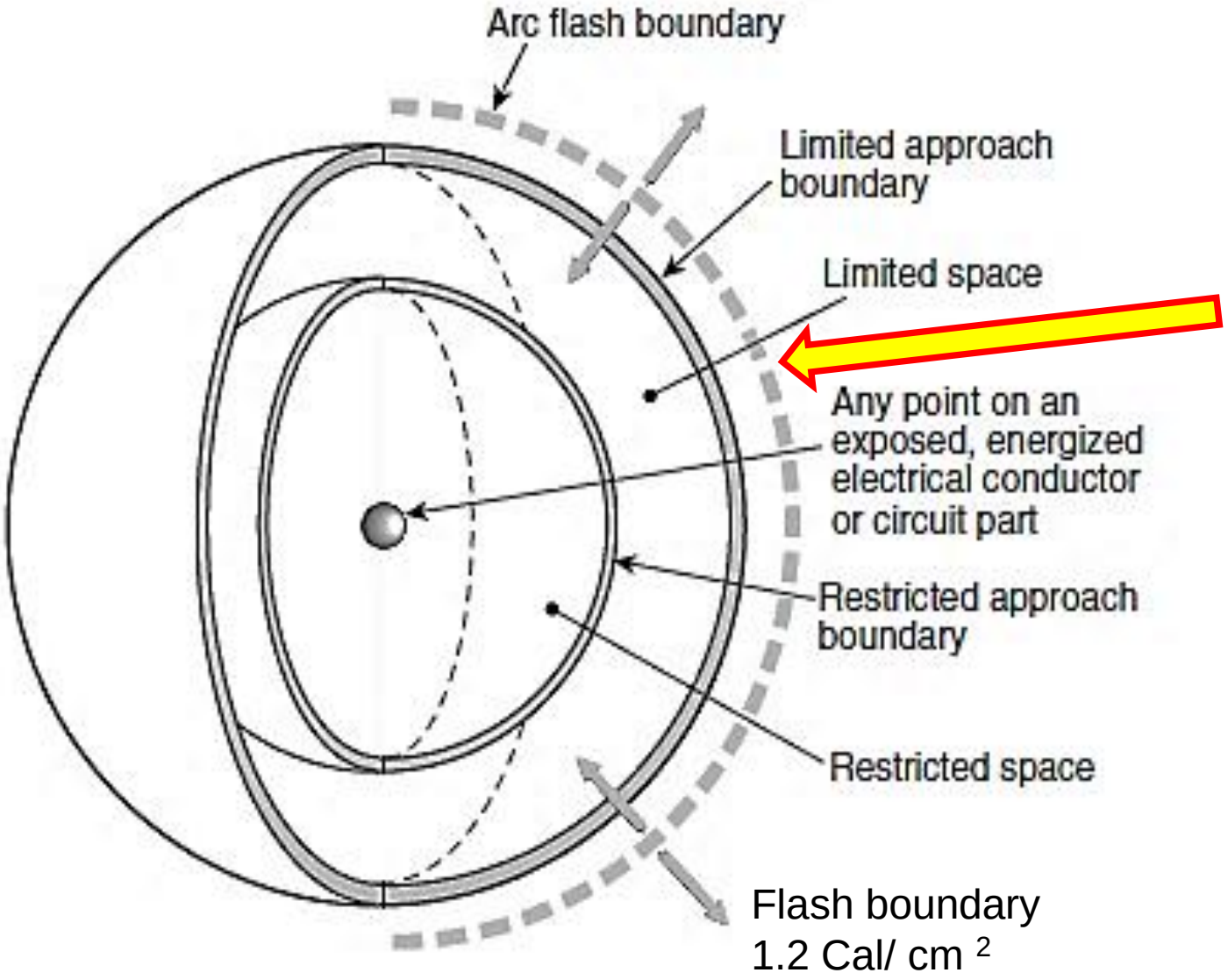

Warning label provides boundary information
Flash Boundary – 4 ft. or calculated
Limited
Restricted


Calculated Arc-Flash Boundary
Appropriate arc-flash PPE must be worn when inside the boundary

Energy Comparisons



Flash Boundary



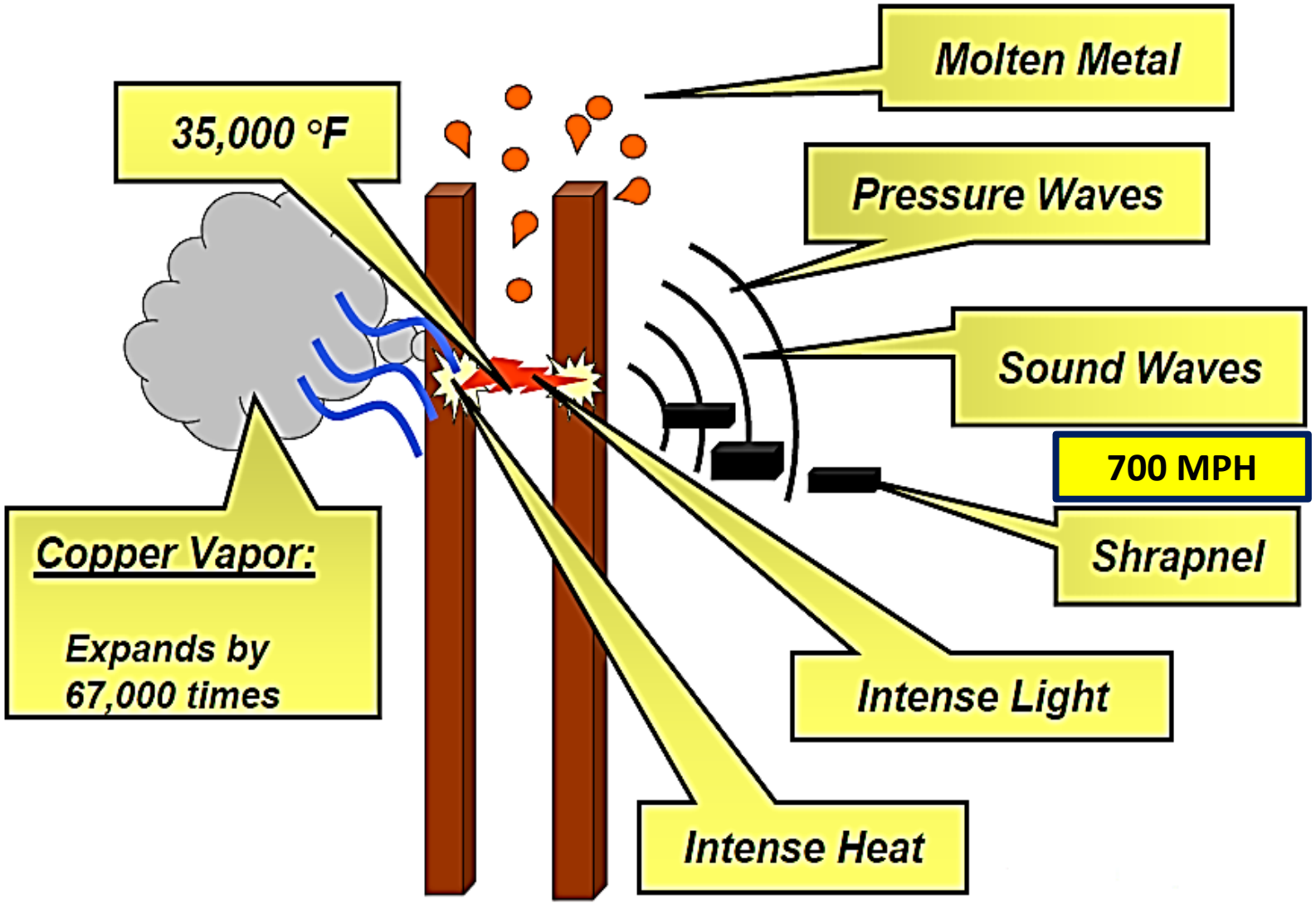
Flash boundary is distance from arc flash where exposed flesh would receive 2nd degree burns

ARC FLASHES

Created by the electric arc; that is, current flow between the electrically conductive materials.

- **Arc may reach 35,000°F**
- **Skin exposed to 158°F for 1 second creates cell destruction**
- **Skin exposed to 2000°F for 0.1 second yields incurable burns**

Electrical Arc Components



130.5 Arc Flash Risk Assessment

(A) The assessment shall be performed:

(1) to identify the arc flash hazards

(2) to estimate the likelihood and potential severity of an arc flash

(3) to determine if additional protective measures or PPE is needed

Document the results of the assessment

(B) Estimate of Likelihood and Severity. The estimate should consider:

(1) the design of the equipment

(2) equipment condition and condition of maintenance

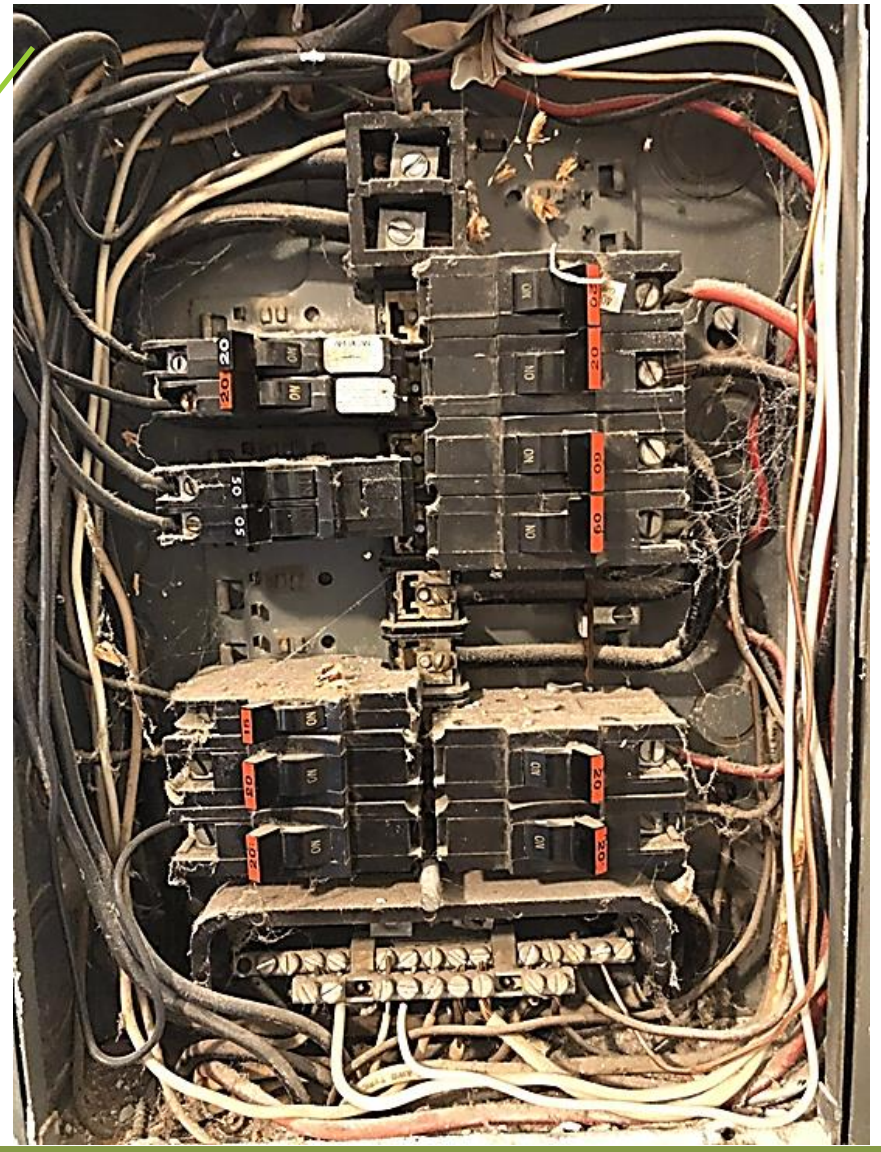
(C) Additional Protective Measures. Follow the hierarchy or protective measures when within the arc flash boundary. Determine the PPE to be used.

130.5(B) Arc Flash Risk Assessment

Document the results of the assessment

(B) Estimate of Likelihood and Severity:
the estimate should considering:
(1) the design of the equipment
(2) equipment condition and
condition of maintenance

?



130.5(F) Methods to Determine PPE

Use either method (1) **or** (2); **not both**.

(1) Incident Energy – See Annex D for 1.2 cal/cm^2
- Use Table 130.5(G) for PPE

(2) Arc Flash Category and Boundary
- See Table 130.7(C)(15)(a) or (b)
- PPE in 130.7 (C)(15)(c)

Arc Flash Identification

Is Arc Flash PPE needed?

See Table 130.5(C) on the following slides.

Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems		
Task	**Equipment Condition**	**Likelihood of Occurrence[b]**
Reading a panel meter while operating a meter switch. **Performing infrared thermography and other non-contact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.** **Working on control circuits with exposed energized electrical conductors and circuit parts, nominal 125 volts ac or dc, or below without any other exposed energized equipment over nominal 125 volts ac or dc, including opening of hinged covers to gain access.** **Examination of insulated cable with no manipulation of cable.** **For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack.**	**Any**	**No**
For ac systems, work on energized electrical conductors and circuit parts, including electrical testing. **Operation of a CB or switch the first time after installation or completion of maintenance in the equipment.** **For dc systems, working on energized electrical conductors and circuit parts of series-connected battery cells, incl. electrical testing.** **Removal or installation of CBs or switches.** **Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.** **Application of temporary protective grounding equipment, after voltage test.** **Working on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 volts.**	**Any**	**Yes**

Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems (Continued)

Task	Equipment Condition	Likelihood of Occurrence[b]
For ac systems, work on energized electrical conductors and circuit parts, including electrical testing. Operation of a CB or switch the first time after installation or completion of maintenance in the equipment. For dc systems, working on energized electrical conductors and circuit parts of series-connected battery cells, including electrical testing. Removal or installation of CBs or switches. Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.	Any	No
Application of temporary protective grounding equipment, after voltage test. Working on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 volts. Insertion or removal of individual starter buckets from motor control center (MCC). Insertion or removal (racking) of circuit breakers (CBs) or starters from cubicles, doors open or closed. Insertion or removal of plug-in devices into or from busways. Examination of insulated cable with manipulation of cable. Working on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center.	Any	Yes

Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems (Continued)		
Task	**Equipment Condition**	**Likelihood of Occurrence[b]**
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	**Abnormal**	**Yes**
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.		
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions: **(1) Insertion or removal of individual starter buckets** **(2) Insertion or removal (racking) of CBs from cubicles** **(3) Insertion or removal (racking) of ground and test device** **(4) Insertion or removal (racking) of voltage transformers on or off the bus**		

Table 130.7(C)(15)(a)

AC Systems Arc Flash Boundaries

Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 volts and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards Parameters: Maximum of 35 kA available fault current; maximum of up to 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant switchgear 1 kV through 15 kV [for clearing times of less than 0.5 sec (30 cycles) with an available fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	N/A (doors closed) 4 (doors open)	N/A (doors closed) 12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)

Table 130.7(C)(15)(c) Protective Clothing

Arc-Flash PPE Category	PPE
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm^2 Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield[b] or arc flash suit hood Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)[d] Leather footwear (AN)

AN = As Needed **SR** = Selection Required

Note: Small letters adjacent to each are referenced in noted at the bottom

Table 130.7(C)(15)(c) Protective Clothing

Arc-Flash PPE Category	PPE
2	Arc-rated Clothing, Minimum Arc Rating of 8 cal/cm^2 Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield[b] and arc-rated balaclava Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)[d] Leather footwear[e]

Table 130.7(C)(15)(c) Protective Clothing

Arc-Flash PPE Category	PPE
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm^2 (104.7 J/cm^2)[a] Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves or rubber insulating gloves with leather protectors (SR)[d] Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Leather footwear

Table 130.7(C)(15)(c) Protective Clothing

Arc-Flash PPE Category	PPE
4	Arc-rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm^2
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR)
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR)
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR)[d]
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f]
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts)[c]
	Leather footwear[e]

There are 70 Cal suits available but not approved by OSHA

Electrical Association

Basic Risk Assessment

130.5(H) Equipment Labeling

Equipment labeled 70E

Field mark equipment with:

(1) Nominal system voltage

(2) Arc Flash Boundary

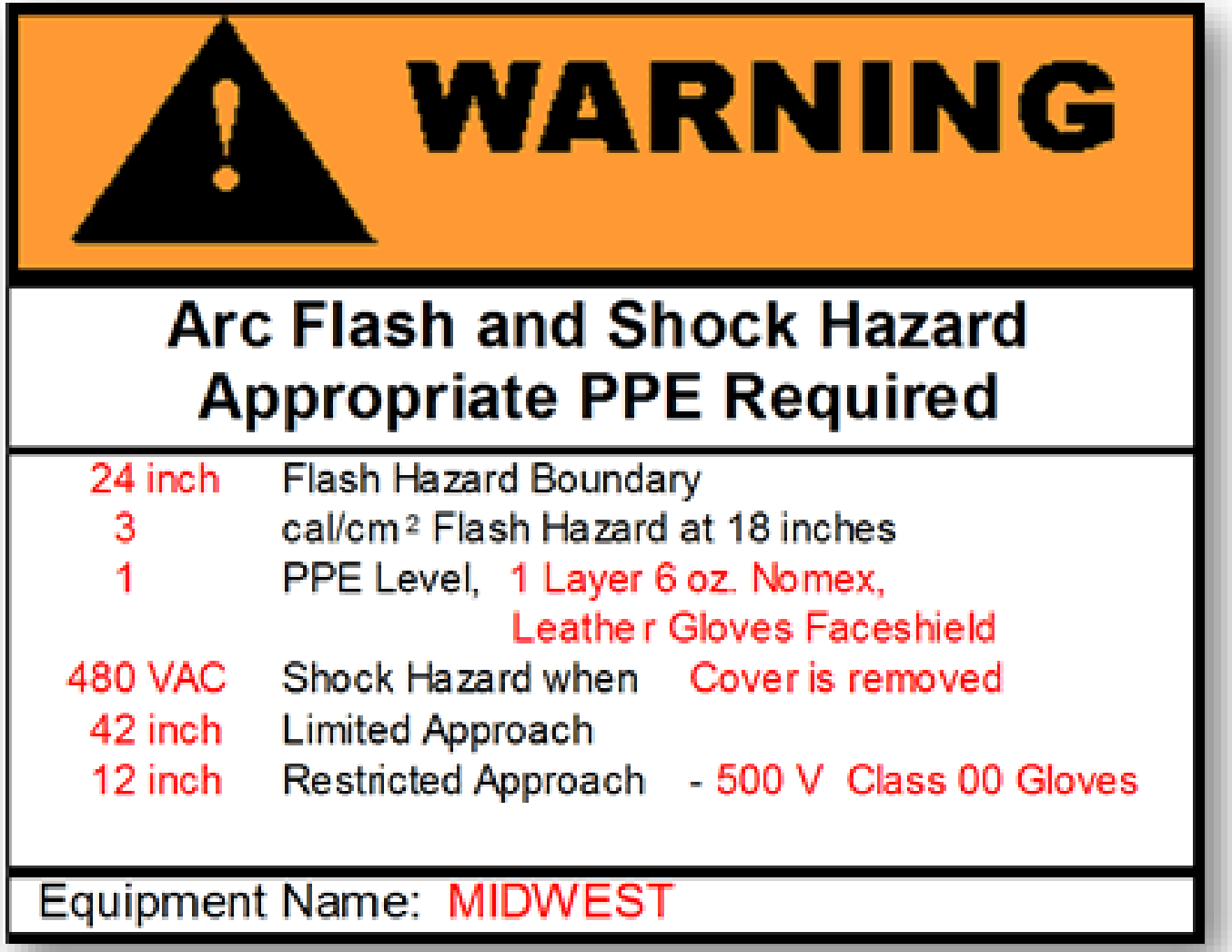
(3) At least one of the following:

  (a) incident energy and working distance, or PPE category

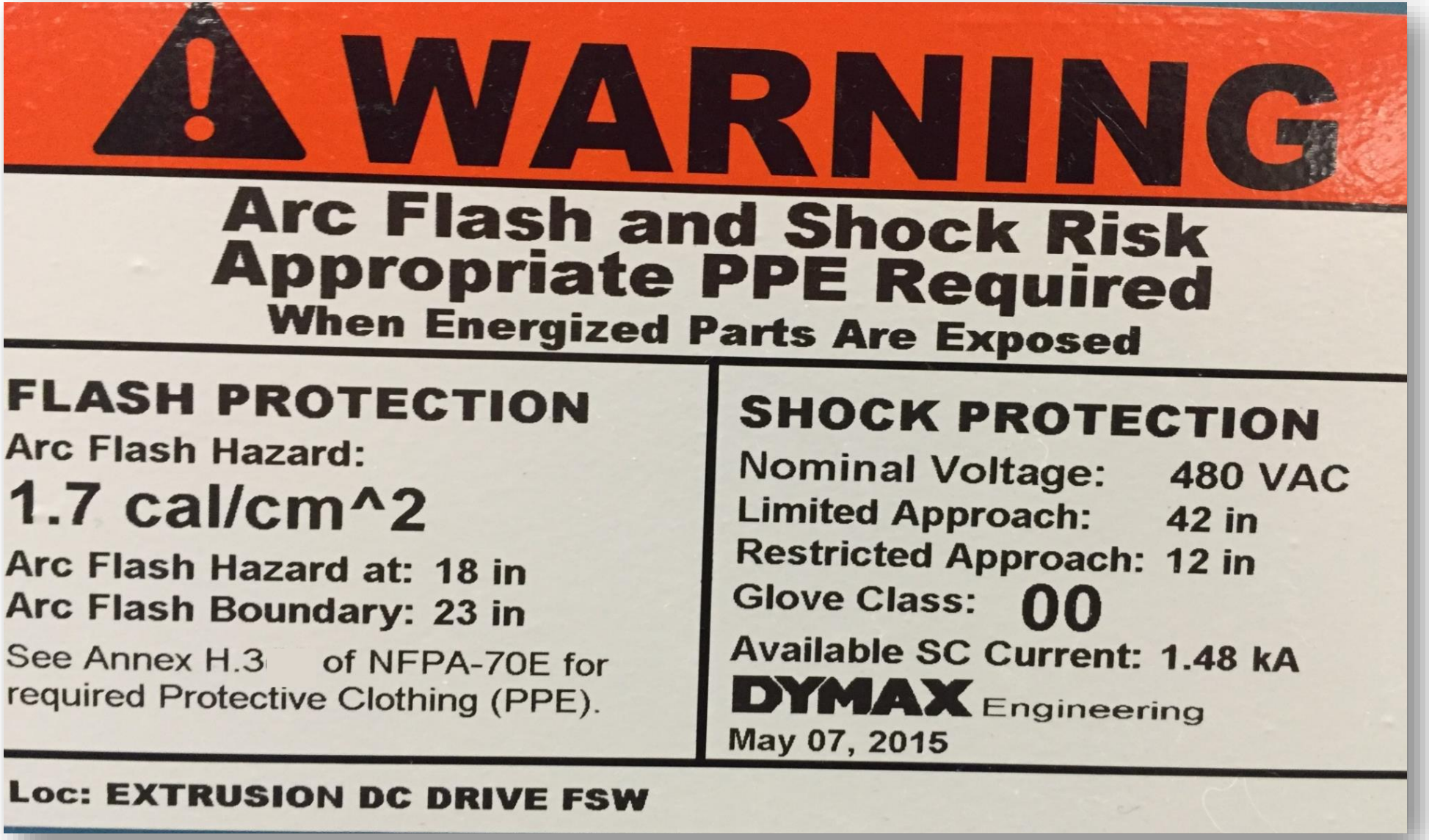
  (b) minimum ARC rated clothing,

  (c) site specific PPE

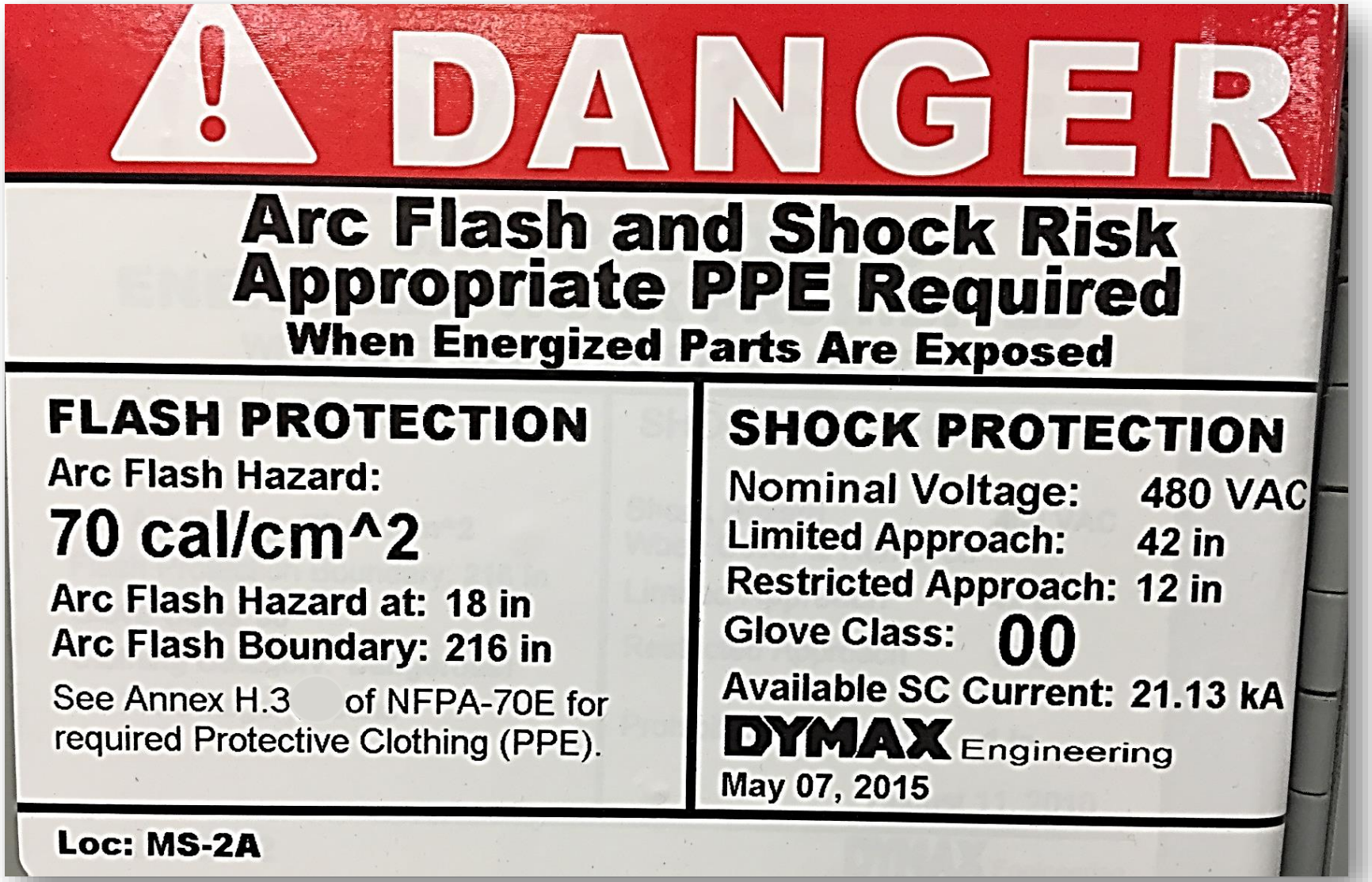
130.7(H) Required Label for 70E & OSHA



Plant Floor Label



Plant Floor Label

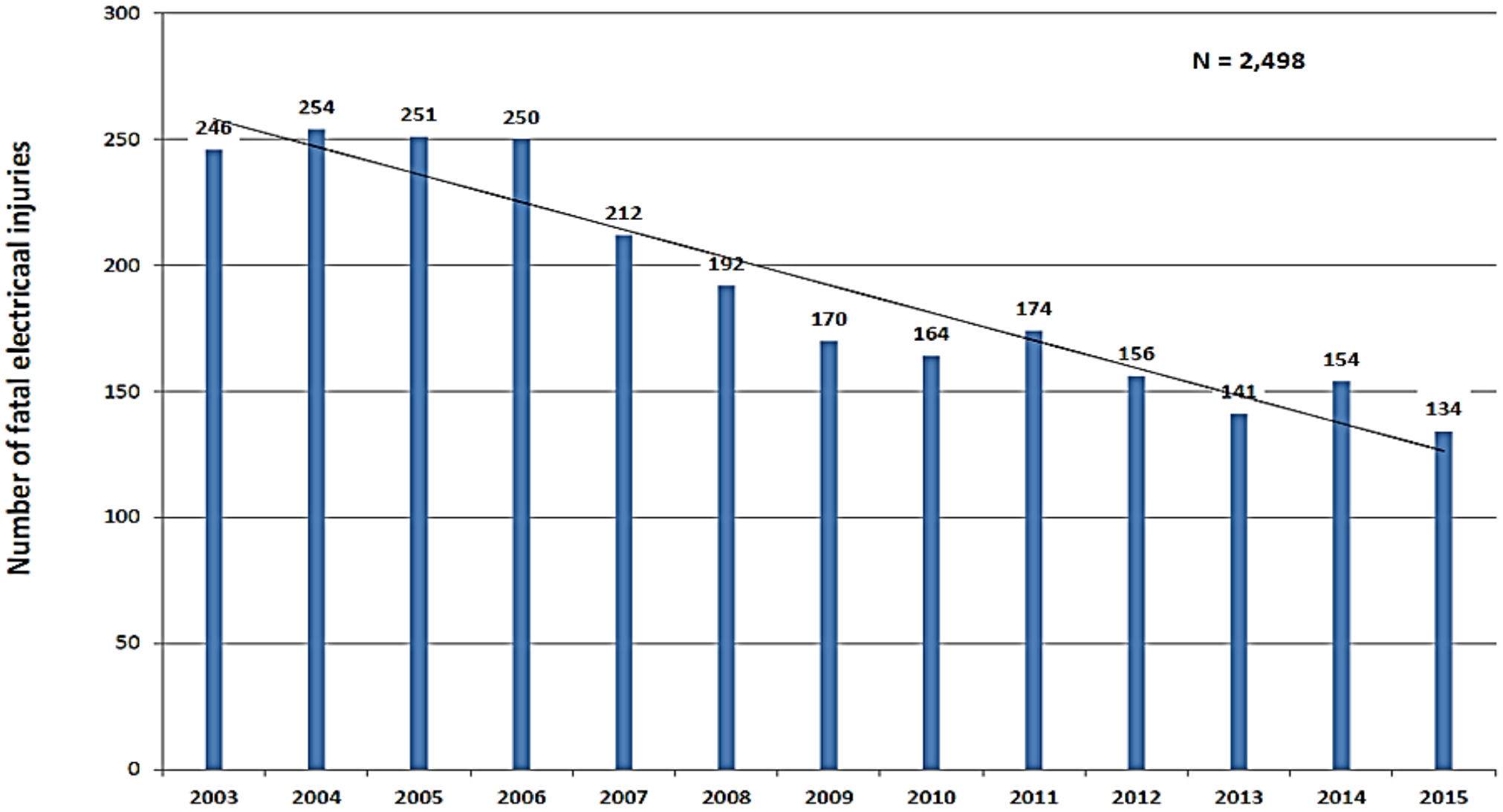


CDC-NIOSH: Perform Lockout/Tagout

***NIOSH found that in 82% of fatalities, people were working on hot circuits *intentionally*!**

Fig. 1

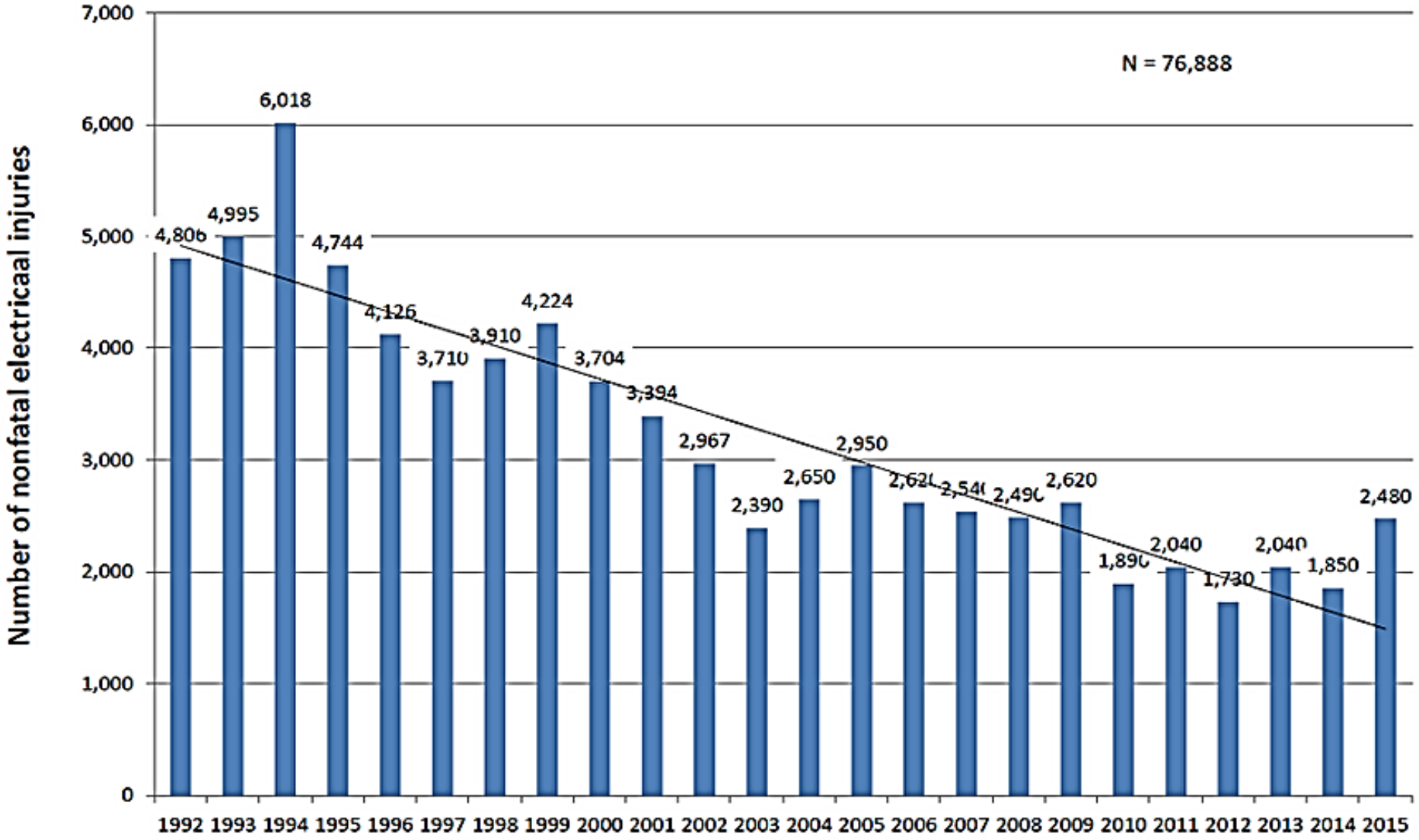
Number of fatal electrical injuries, by Event Code, all ownerships, 2003-2015



Electrical Safety Foundation International using US Bureau of Labor Statistics, 2003-2015

Fig. 6

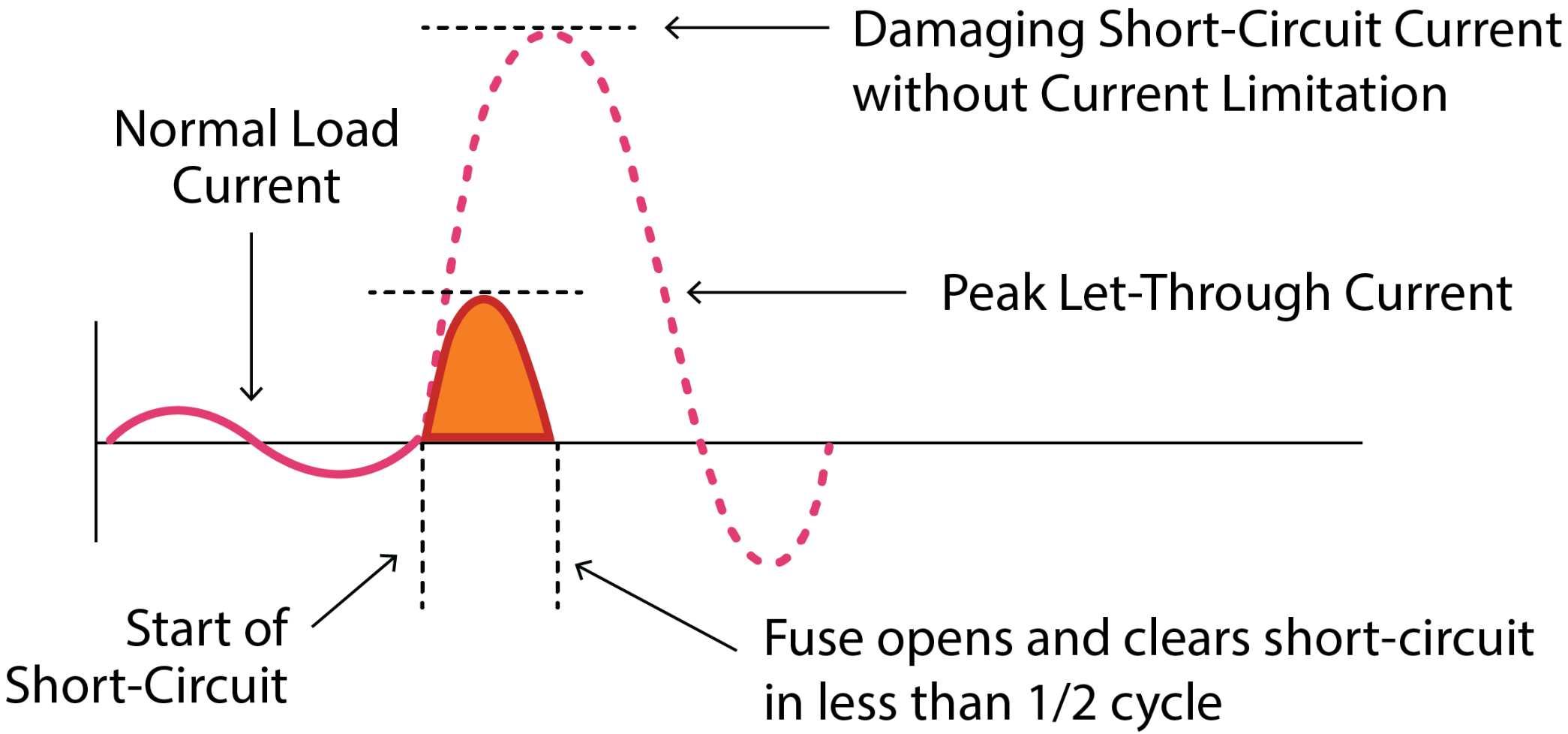
Number of nonfatal electrical injuries, by Event, Private Industry, 1992-2015



Electrical Safety Foundation International using US Bureau of Labor Statistics, 1992-2015

Arc Flash and Arc Blast

Current-Limiting Fuse – Let-Through



Exceeding Interrupting Rating

Considerable damage can result if the interrupting rating of a protective device is exceeded by a short-circuit current.

Arc flash in low-voltage switchboard cubicle

Other Arc Flash Safety Considerations

- Stay alert – don't get distracted
- Do not work impaired – fatigue, sick, drugs
- Be aware that the situation and scope of work may change
- Don't reach in blindly
- Make sure doors are secured
- Ensure work is adequately illuminated
- Ensure your view of the work is not obstructed
- Ensure you are not wearing conductive objects
- Be aware of conductive tools and equipment around you
- Confined space work
- Defeated safety interlock
- Resetting of tripped circuits

130.7 PPE

- PPE is to be maintained in a safe, reliable and clean condition.
- Eye Protection must be worn. Eye & face protection equipment should meet requirements specified by the American National Standards Institute Z87.1: Practice for Occupational and Educational Eye & Face Protection.
- The safety eyewear must have **Z87 or Z87+** marked on the frame or lenses
- Face shield shall have arc rating for equipment. Must protect forehead, face, ears, neck, chin
- Hair net or beard nets must be arc rated

Personal Protective Equipment (PPE)

Electrical Association

Guide to selecting correct PPE found in these sections of 130.7(C)

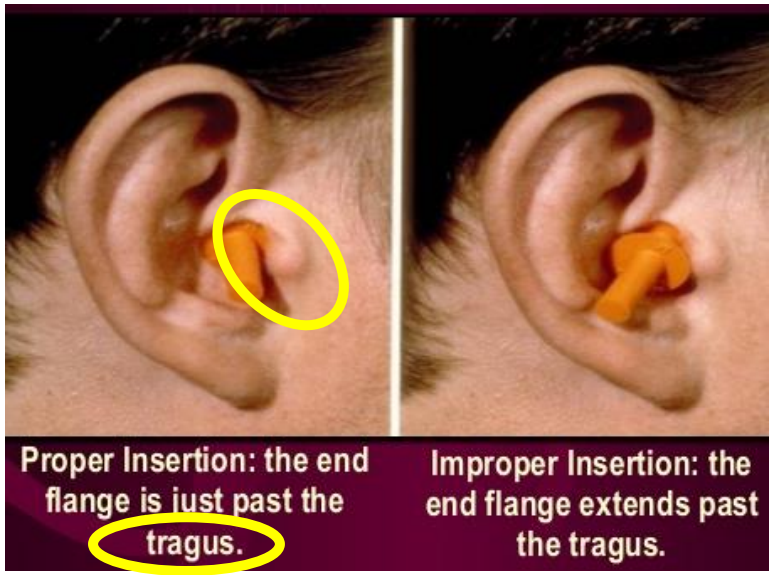
(C)	Description	(C)	Description	(C)	Description
(1)	General	(6)	Body Protection	(11)	Clothing Material Characteristics
(2)	Movement & Visibility	(7)	Hand & Arm Protection	(12)	Clothing NOT Permitted
(3)	Head Face Neck, Chin	(8)	Foot Protection	(13)	Care & Maint. Arc-Rated Clothing
(4)	Eye Protection	(9)	Protective Clothing	(14)	Standards for PPE
(5)	Hearing Protection	(10)	Arc Flash Protective Equip.	(15)	Arc Flash PPE Category Method

Personal Protective Equipment (PPE)

Hard Hat Voltage Insulation Protection Comparison

- **Class G** hard hats protect from electric shock of voltages up to 2,200 volts.
- **Class E** hard hats protect from electric shock of voltages up to 20,000 volts.
- **Class C** hardhats provide impact protection but NO protection from electrical hazards.

Personal Protective Equipment



Hearing protection must be worn

Body protection needs rated clothing incl rainwear & outerwear

Acetate, nylon, polyester, spandex shall NOT be next to the skin (underwear, etc.)

Hand / Arm protection

- Rubber insulated gloves to provide electric shock protection.
- Leather gloves provide:
  - Arc Flash protection from burns
  - Damage protection of rubber insulated gloves
- Rubber sleeves where needed for shock protection

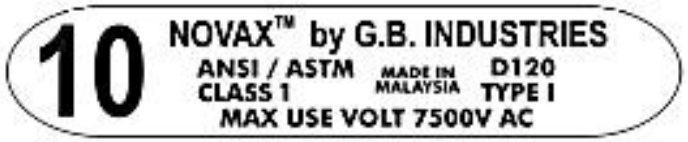
Foot protection: dielectric footwear where step and touch potential is present. **Heavy-duty leather footwear are required for over 4 cal/cm^2**

Personal Protective Equipment (PPE)

- Layering of clothing: You may wear flammable (cotton, wool) but not meltable garments (synthetics of nylon, polyester, etc.) *under* arc-rated clothing
- Arc suits must be easily removable. If supplied with air hose, the hose must be arc rated.
- **An arc-rated balaclava must be worn with a face shield if the back of the head is within arc flash boundary.** Article 130.7(C)(10)(b)(1) not required if using a flash hood
- A **hood is required** if the incident energy is anticipated to exceed 12cal/cm^2

Article 130.7(C)(10)(b)(2)

Class of Glove – Ratings Phase-to-Ground *or* Phase-to-Phase if Close Quarters

CLASS	TEST AC VOLTS	USE AC VOLTS	USE DC VOLTS	LABEL COLOR	LABEL IMAGE
00	2,500	500	750	Beige	
0	5,000	1,000	1,500	Red	
1	10,000	7,500	11,250	White	
2	20,000	17,000	25,500	Yellow	
3	30,000	26,500	39,750	Green	
4	40,000	36,000	54,000	Orange	

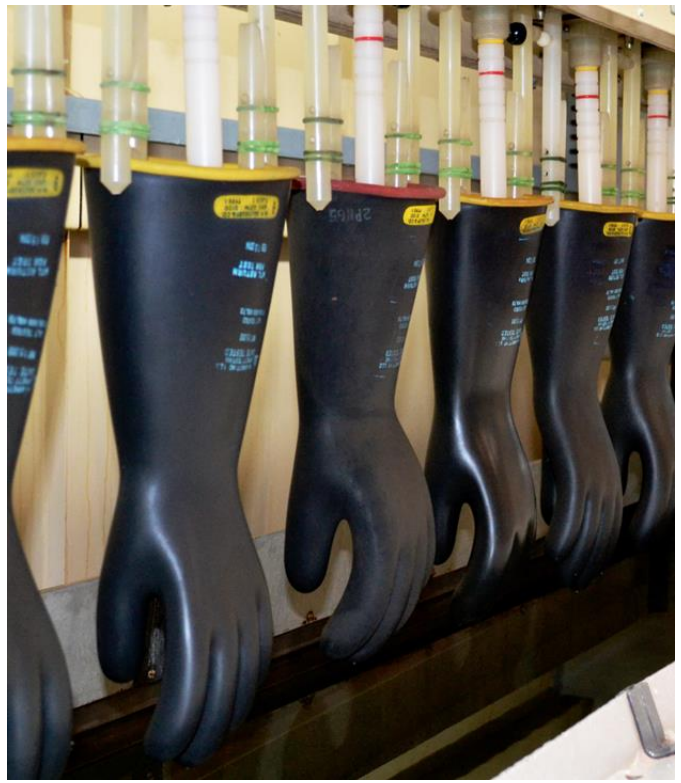
Personal Protective Equipment (PPE)

Electrical Association

Generally inspect (hand roll) before each use.

Inspect before each use **and every 6 months.**

Table 130.7(C)(7)(b)



Inspect before each use **and every 12 months.**

Working Live

Anything you would do differently here

?

△ Rating Flame Resistant vs Arc Resistant

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Arc Rated, Tested:

(1) Arc Thermal Performance Value (ATPV) Threshold of 2nd degree burns and

(2) Energy of Break-Open Threshold (E_{BT}) Holes in the fabric--whichever point is reached first is rated in cal/cm^2

FR - ***Flame resistant rating*** NOT the same as ***AR rating***

All AR-rated clothing is Flame Resistant, but not all FR-rated clothing is Arc Resistant.

Arc rating and *flame resistant* are two different things but are often confused because they go together. You can't have an arc rating without the material being flame resistant. According to the arc rating standards (ASTM F1506, ASTM F1959, IEC 61482-2, IEC 61482-1-1 Method A and IEC 61482-1-1 Method B), clothing is actually required to be flame resistant before it can even be tested to determine its arc rating.

130.7(D)(1) Other Protective Equipment

- Electrically rated tools
- Designed to protect against voltage breakthrough

Tools with comfort-grip handles

Not insulated

Tools rated for voltage used on

Electrically insulated

130.7

- Voltage rated fuse holders are to be used when replacing fuses in live circuits

- 130.7(D)(1)(c)
- Ropes and handlines used within the Limited Approach boundaries shall be non-conductive. Fiberglass reinforced plastic push rods are considered non-conductive.

- 130.7(D((1)(e)
- Portable ladders are to have non-conductive side rails

130.7(E) Alerting Techniques

- Safety signs and tags must be used to warn employees of the electrical dangers

- Barricades are to be used with signs to keep employees away from electrically dangerous areas

130.7(E)(2) Safety Barricades

Alerting Devices

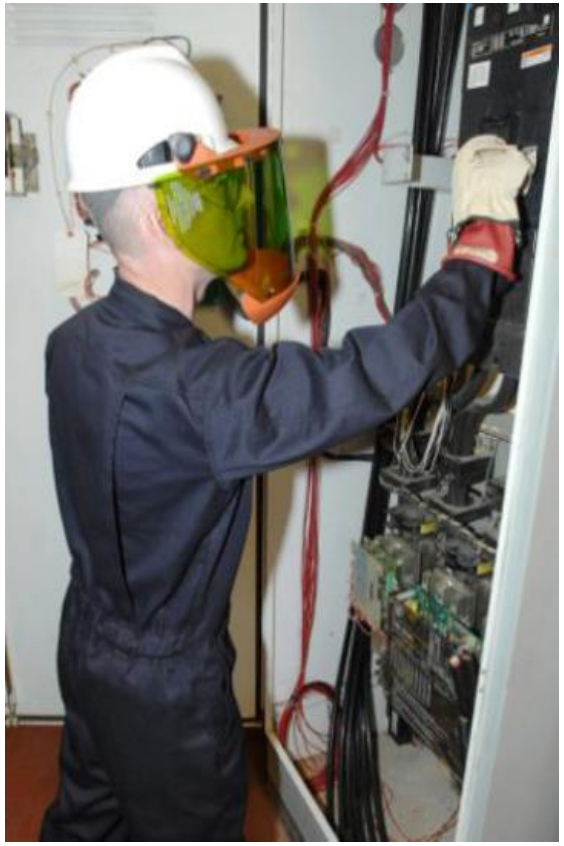
Barricades are to be used with signs to keep employees away from electrically dangerous areas

PPE Needs Calorie Count / Voltage Rating

Employee Clothing

- **Employers shall insure** that the clothing worn by workers exposed to possible flames or arcs will not increase the extent of injury
- Clothing containing acetate, acrylic, nylon, polyester, **polyethylene, spandex may not be used (either alone or in blends)**
  - Unless treated and certified as Fire Resistant (FR) rating
- Hair nets, head covering and hard hat liners must also be AR rated

Personal Protective Equipment (PPE)



Hazard Risk Categories

Category 1

Category 2

Category 3

Category 4

This concludes the

70E Electrical Safety Training 2024

Electrical Association

Thank You for Attending!