




OSHA/70E – 2021 EDITION ELECTRICAL TRAINING

BY


*ELECTRICAL ASSOCIATION
2021 VERSION*



ELECTRICAL ASSOCIATION

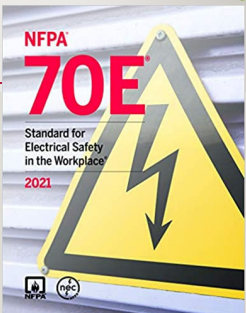
- **Disclaimer:** Through the presentation of this course and or these materials, no representation actual or implied, is made that the trainer or EA/ETN is setting or enforcing specific standards, or is providing peer review, certification, accreditation, or product endorsement or testing.


The material is adapted from the 2021 NFPA® 70 E.
Actual articles in their entirety are required to maintain compliance.




NFPA 70E - 2021 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 AND TESTING




NFPA 70B Recommended Practice for Electrical Equipment Maintenance
MTS Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems - 2019 Edition by ANSI/NETA MTS



DEFINITIONS

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.



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
- **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 ...

DEFINITION OF 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 2021 Definitions: 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.

REQUIRED BY NEC 2020 SECTION 110.16(A) IN OTHER THAN DWELLING UNITS- ON SERVICE EQUIPMENT

NATIONAL ELECTRICAL CODE 2020- 110.16 ARC FLASH HAZARD WARNING

- **Flash protection.**
- **Electrical equipment, such as switchboards, panelboards, industrial control panels... , Motor Control Centers 1200 A or more, that are in other than dwelling occupancies and are likely to require examination, adjustment or servicing while energized shall be field marked to warn qualified persons of potential electric arc flash hazard.**
- **The warning must contain information on nominal circuit voltage, available fault current, clearing time of OC protection, and date label was applied**

THIS NEC REQUIRED LABEL ONLY HAS FAULT CURRENT NOT INCIDENT ENERGY

110.24 Available Fault Current

Non-dwelling unit service equipment required to be field-marked with the amount of available fault current when installed or modified

Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available fault current

The field marking(s) shall include the date the fault current calculation was performed and be of sufficient durability to withstand the environment involved

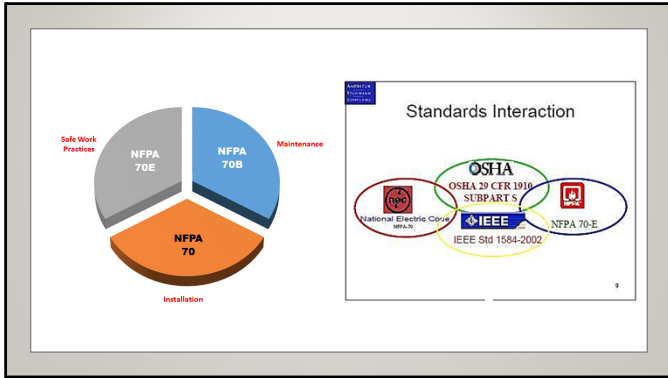
NEC is a Code- 2020

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

NEC 110.16 –INFORMATIONAL NOTE I

- **NEC 2020 Art 110.16 IN #1 states:**
 - **“NFPA 70E - provides guidance such as determining severity of potential exposure, planning safe work practices, and selecting personal protective equipment (PPE)”**
- **70E 2021 Art. 90.1 Purpose**
 - **The purpose of this code is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.**



- State / federal OSHA enforcement- Some States as MN, have own OSHA- MNOSHA
- US OSHA Calendar Year 2018:
- Inspections: 32,023
- Fatalities Investigated 4,779 (TOP 4)
 - Falls 33.5%
 - Struck by Object: 11.1%
 - Electrocutions 8.5%
 - Caught in Between * 5.5%

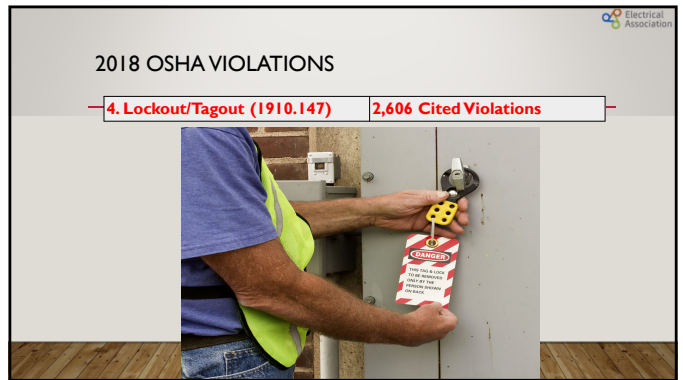
* this category includes construction workers killed when caught-in or compressed by equipment or objects, and struck, caught, or crushed in collapsing structure, equipment, or material

VIOLATION	MAXIMUM PENALTIES	
	CURRENT	EFF. CIVIL. LAW-72, 3019
Other-than-serious violation	\$12,934 per violation	\$13,260 per violation
Serious violation	\$12,934 per violation	\$13,260 per violation
Failure to comply with posting requirements	\$12,934 per violation	\$13,260 per violation
Failure to correct a violation	\$12,934 per day until corrected	\$13,260 per day until corrected
Repeated violation	\$129,336 per violation	\$132,598 per violation
Willful violation	\$129,336 per violation (also subject to a minimum of \$9,239 per violation)	\$132,598 per violation (also subject to a minimum of \$9,472 per violation)

± 2.5% ↑

TOP 10 OSHA VIOLATIONS

OSHA Standard	2019 Violations
1. Fall Protection: General Requirements (1926.501)	6,010
2. Hazard Communication (1910.1200)	3,671
3. Scaffolding (1926.451)	2,813
4. Lockout/Tagout (1910.147)	2,606
5. Respiratory Protection (1910.134)	2,450
6. Ladders (1926.1053)	2,345
7. Powered Industrial Trucks (1910.178)	2,093
8. Fall Protection: Training Requirements (1926.503)	1,773
9. Machine Guarding (1910.212)	1,743
10. Personal Protective Equipment: Lifesaving Equipment and Eye and Face Protection (1926.102)	1,411




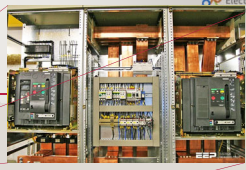
- 70E - ELECTRICAL SAFETY PROGRAM**
- > Establish Electrically Safe Work conditions (ESWC)
 - > Plan and anticipate safe work
 - > Identify and reduce risks
 - > Train qualified employees
 - > Use proper tools and clothing

- GENERAL REQUIREMENTS- 70E 105.1**
- Chapter I
 - 105.1 addresses electrical safety work practices as well as procedures for workers exposed to electrical hazards
 - (A) Employer must
 - 1) Establish, execute, and document safety related work practices and procedures required by the standard (70E)
 - 2) Provide employees with training in the employer's safety related work practices and procedures.
 - (B) Employee
 - The employee shall comply with the safety-related work practices and procedures provided by the employer.

GENERAL REQUIREMENTS- 70E

110.1 PRIORITY

Hazard elimination shall be the first priority in the implementation of safety related work practices

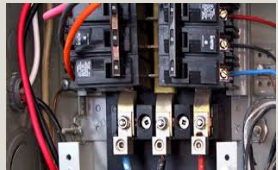



GENERAL REQUIREMENTS- 70E

110.3 ELECTRICALLY SAFE WORK CONDITION

Energized electrical conductors and equipment operating in excess of 50 volts shall be placed in an electrically safe working condition before an employee performs work if either of the following conditions exist:

- (1) an 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,



GENERAL REQUIREMENTS- 70E

110.4 ENERGIZED WORK

(A) Additional Hazards or Increased Risk
Energized electrical work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.


Examples of such conditions include interruption of life support equipment, deactivation of emergency alarm systems, and shutdown of ventilation systems for hazardous locations.




GENERAL REQUIREMENTS- 70E

110.4 ENERGIZED WORK

(B) Infeasibility Energized electrical work shall be permitted 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.



GENERAL REQUIREMENTS- 70E

110.4 ENERGIZED WORK

(C) Equipment Operating at Less Than 50 Volts
Equipment operating at less than 50 volts may be worked on with out de-energizing if it determined the capacity of the source does not expose workers to electric arcs.



GENERAL REQUIREMENTS- 70E

110.4 ENERGIZED WORK

(D) Normal Operating Condition

- (1) The equipment is properly installed
- (2) The equipment is properly maintained
- (3) The equipment is used as per its instruction and listing
- (4) The equipment doors are in place and closed
- (5) The equipment covers are in place and secured
- (5) There is no evidence of impending failure

110.5 ELECTRICAL SAFETY PROGRAM

- (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
- (E) **Safety Program Principles:** Have a set plan or process to provide safe operations based on safety principles before the work is started

SAFETY PROGRAM (CONT)

- (F) **Electrical Safety Program Controls** are 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 risk -

HIERARCHY OF RISKS

- **Elimination**
- **Substitution**
- **Engineering controls**
- **Awareness**
- **Administrative controls**
- **Personal Protective Equipment (PPE)**

HEIRARCHY OF RISKS

Table E.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

SAFETY PROGRAM (CONT)

- (I) **Job briefing and planning** - before the job commences conduct job briefing
 - Hazards, PPE, assessment, work procedures, tools and equipment, any special requirements- change of scope
- (J) **Incident investigation:** - Investigate all incidents as in - jury or death and also "near miss" incidents
- (K) **(NEW)** Employer must establish a ESWC policy that complies with 110.3

DOCUMENT ALL !!!

SAFETY PROGRAM (CONT)

- (L) **(NEW)** Electrical Safety Program shall include information required by one of the following:
 - (1) A lockout/tagout program in accordance with 120.1(A)
 - (2) A reference to the employer LOTO established program
- (M) **Auditing:** (1) process and procedures compliance for program- **not to exceed 3 year intervals;** (2) Field work -**not to exceed 1 year** - (3) Lock out/ tag out **in the field...**

DOCUMENT ALL !!!

70E 110.6 ELECTRICAL SAFETY TRAINING REQUIRED



- 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 electrical energy hazards. **They shall be trained in safety related work practices needed to avoid the hazards**
- **Retraining not to exceed 3 years**
- Training can be in the classroom or on the job or both.
- **Must be trained in lock-out/tag-out procedures and their responsibility in execution**

70E 110.6 -ELECTRICAL SAFETY TRAINING REQUIRED



- Documents detailing Lock Out Training and Compliance **require name ,date and content of training for each employee for the duration of employment**
- Emergency response training required
 - **Must be trained to release a victim from a live circuit - with refresher annually**
 - **If responsible for responding, they must have CPR and Automated External Defibrillator (AED) training- renewed as per requirements of certifying agency**

70E 110.6 (A)(1) EMPLOYEE TRAINING



- (a) A qualified person shall also 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.**
- (b) These qualified individuals shall be familiar with the precautionary techniques...
- (c) 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) Be able to distinguish exposed live conductors from other electrical equipment
 - (2) be able to ascertain nominal voltages
 - (3) be able to determine approach distance requirements
 - (4) be able to perform the following tasks:

QUALIFIED – CONTINUED



- Perform job safety planning
 - Identify electrical hazards
 - Assess the associated risk**
 - 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**

110.6 (A) (2)



- **UNQUALIFIED PERSONS**
 - **Shall be trained in, and familiar with, electrical safety for their position.**
 - Be aware of electrical situations that may be unsafe- **in their normal duties**
 - **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.

110.6 (A) (3) RE-TRAINING REQUIREMENTS - EVERY 3 YEARS



- Also, retraining required if:**
- 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 re-training** before performing tasks
 - 4) Safety practices were not in normal scope of work
 - 5) The employee's job duty changes
- **Retraining at intervals not to exceed 3 years**

TYPES OF TRAINING | 10.6 (A)(4)



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.**

TRAINING DOCUMENTATION | 10.6 (A) (5)



- **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 employment plus 7 years**
- 3) **The documents must contain the name, date, content of training.**

10.6 (B) LOTO PROCEDURE TRAINING



- 1) **Initial training: Each person involved with LOTO procedures must be trained and be knowledgeable regarding their role in the execution of the procedure**
- 2) **Retraining: Retraining is to be at least every three years OR**
 - **Whenever the procedure is revised**
 - **When verifying correct implementation**
 - **Employees are not complying with procedures**
- 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**

10.6 (C) EMERGENCY RESPONSE TRAINING



- **Employees responsible for responding to medical emergencies are to be trained, verified, and documented annually:**
- **In first aid and emergency procedures**
- **If responsible for responding, they must have CPR**
- **If part of the employers plan, Automated External Defibrillator (AED) training**
- **Training for this requirement is to be as often as the certifying body requires**

10.7 HOST AND CONTRACT EMPLOYER




- (A) **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**
- (B) **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**
- (C) **Document that the affected employees have been informed**

10.8 - TEST INSTRUMENTS




- (A) **Only qualified persons shall perform tasks of testing, troubleshooting, and voltage measurement within the limited approach boundary- 50 volts or more.**
- (B) **Make sure the test equipment is rated for the circuits or equipment – and is designed for the environment where used.**
- (C) **Use test equipment according to the designed applications**
- (D)-(E) **Verify safe test instruments and equipment through visual inspection and verify proper operation with known test operation.**

CAT III 600V METERS



Overvoltage category	In brief	Examples
CAT IV	Three-phase at utility connection, any outdoor conductors	<ul style="list-style-type: none"> Refers to the "origin of installation," i.e., where low-voltage connection is made to utility power Electricity meters, primary overcurrent protection equipment Outside and service entrance, service drop from pole to building, run between meter and panel Overhead line to detached building, underground line to well pump
CAT III	Three-phase distribution, including single-phase commercial lighting	<ul style="list-style-type: none"> Equipment in fixed installations, such as switchgear and polyphase motors Bus and feeder in industrial plants Feeders and short branch circuits, distribution panel devices Lighting systems in larger buildings Appliance outlets with short connections to service entrance
CAT II	Single-phase receptacle connected loads	<ul style="list-style-type: none"> Appliance, portable tools, and other household and similar loads Outlet and long branch circuits Outlets at more than 10 meters (30 feet) from CAT III source Outlets at more than 20 meters (60 feet) from CAT IV source

110.9 -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 protec.)
- (E) Attachment plugs
 - Strain relief grips required w/all prongs present
- (F) Use per manufacturer's instructions

110.10 – 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 or the assured equipment grounding conductor shall be used.

110.11 – OVERCURRENT PROTECTION

- DO NOT** alter the overcurrent protection on circuits or conductors

Fuses and Circuit Breakers

- In order to prevent circuits from overheating, devices called fuses and circuit breakers are added to circuits.



110.12 – (NEW) EQUIPMENT USE

- Equipment shall be used IAW manufacturer's instruction

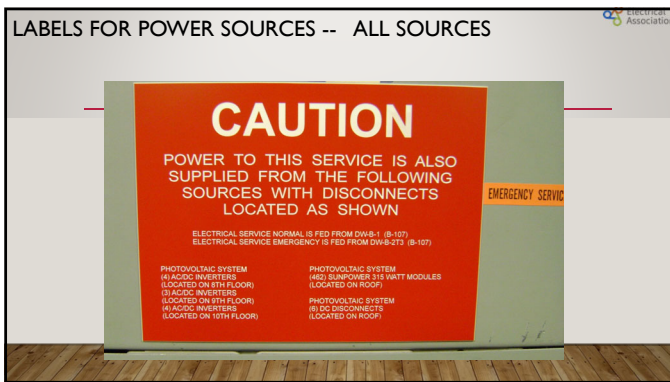
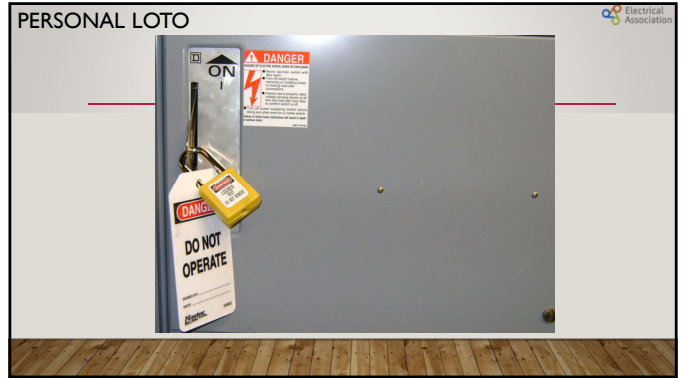


ESTABLISHING AN ELECTRICALLY SAFE WORK CONDITION

- NFPA 70E 2021 - Article 120**

120.1 – LOCKOUT /TAGOUT PROGRAM (NEW)

- (A) Each employer will have a policy for LOTO
- (B) Each employer will provide the materials and equipment necessary for LOTO
- Each employer shall provide training on LOTO and will audit the program to conform with 110.1



120.2 LOTO PRINCIPLES –

- (A) All circuits are considered live until verified de-energized and tested.
 - If disconnected but not locked out, circuits are not considered electrically safe
- (B) Each person locks out the equipment they are working on.
- (C) Apply LOTO procedures based on current conditions and up-to-date electrical drawings
- (D) All energy systems (including stored energy) must be controlled
- (E) Test for interlock and interconnected systems to avoid live power
- (F) Do not use pushbutton interlocks to provide lock out function – Use approved disconnecting devices



120.2 LOTO PRINCIPLES

- (G) Identification of LOTO devices are to be readily identifiable
- (H) Coordination
 - Have a workplace plan of - who does what- coordinated procedures
 - Lock with controlled keys (or combination) and identification as to whose lock is on the equipment
- (I) 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

Training on procedures must be completed before working and at intervals not to exceed 3 years....Training must be documented

LOTO STORAGE



120.3 LOTO DEVICES



- 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
- If 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



LOTOTO: LOCK-TAG -AND TEST- 120.5



- Electrically safe work conditions: Established by these eight 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
 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)



VOLTAGE TESTING : APPROVED METHOD?



120.5(7) LOTO DEVICES



NO



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

120.5(7) LOTO DEVICES



yes



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

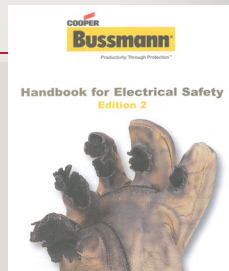
NFPA 70E ARTICLE 130

WORK INVOLVING ELECTRICAL HAZARDS

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.

BUSSMANN.COM FC2 CALCULATOR



130.1 GENERAL CONDITIONS

- When ESWC cannot be created, then **work practices must protect the worker.** (greater than 50V)
- The **incident energy analysis** can be completed by using table 130.7 (C)(15)(a) for AC systems or (b) for DC systems and (c) for PPE ratings
- Incident energy can be determined by the above tables in 70E or by using calculations by IEEE 1584...

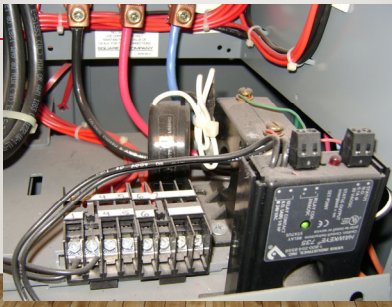
OSHA 1910.333 / 70E 2021 ART 130.2

- "Electrically Safe Working Conditions."
- **Energized electrical conductors and circuits must be placed in an electrically safe work condition before performing work if the following conditions exist:**
 - The employee is within the limited approach Boundary
 - If the employee interacts with non exposed circuits but could be exposed to arc flash
- (A) Working on circuits energized can be done if:
 - (1) de-energizing would **introduce additional hazards** or increased risk- **or**
 - (2) **if it is infeasible** to work on circuits in a de-energized state.
 - (3) Live parts that operate at less than 50 volts to ground need not be de-energized **if there will be no increased exposure** to electrical burns or to explosion due to electric arcs. Additional risk include arc blast from battery systems or capacitors

OSHA 1910.333 - 70E- 130.2 (A)

- **IN 1: Examples of increased or additional hazards include: interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment.**
- **IN 2: Examples of work that may be performed **on or near** energized circuit parts because of infeasibility due to equipment design or operational limitations include: testing of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous industrial process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.**

POWER AND DATA INTERFACES "ON OR NEAR"



OSHA 1910.333- 70E- 130.2 (A) (2) INFEASIBILITY

- "Energized parts." **If the exposed live parts are not de-energized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved.** Such work practices shall protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object.
- The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts. Specific work practice requirements are detailed in paragraph (c) of this section

130.2 (A) (3) LESS THAN 50V.

- If equipment or systems are operating at less than 50V, the risk of electrical shock is reduced. However, there may still be a risk of Arc flash. IF there is no risk of Arc flash, then no additional requirements are needed and the circuits need not be de-energized .



70E 130.2 (A) (4) NORMAL OPERATION

- Normal operation of equipment is permitted if:
 - The equipment is properly installed and maintained according to the Mfg. instructions
 - Equipment doors are closed and secured
 - Equipment covers are in place and secured
 - There is no evidence of impending failure

70E 130.2 (B) ENERGIZED ELECTRICAL WORK PERMIT

- (1) A work permit is required if:
 - The work is performed within the restricted approach boundary
 - If the employee interacts with conductive parts that are not exposed but if there is a danger of exposure to an Arc Flash
- (2) Elements of work permit - following slides
- (3) Exemptions to Work permit for qualified employees with appropriate PPE and appropriate work practices when:
 - Testing and troubleshooting
 - Thermography, ultrasound, and visual inspection – not crossing the restricted approach boundary
 - Moving to or from electrical equipment if not doing work within the restricted approach boundary
 - General housekeeping

WORK PERMIT EXAMPLE -130.2 (B) 2 ON-LINE

<p>Energized Electrical Work Permit</p> <p>Job/Work Order: 00001 / 12562014</p> <p>Circuit Description: 120V 3 phase 30 A</p> <p>Equipment Description: 0100 equipment address</p> <p>Job Location: [Blank]</p> <p>Work To Be Done: Work on bus bar of equipment</p> <p>Justify Energized Work: NETA 70E 2015 130.2(B)</p> <p>Safe Work Practices To Be Employed: NETA 70E 2015 130.2(B)</p> <p>Means to Restrict Access of Unqualified Persons: NETA 70E 2015 130.2(B)</p> <p>Job-specific Hazard Estimating Acknowledgement: [Blank]</p> <p>Employee in Charge of Energy: [Blank]</p>		<p>Generated by: http://www.electricalassociation.com using the NETA 70E table and permit tool on 2/26/2014</p> <p>Equipment Type: Panelboards or other equipment rated > 240 V and up to 600 V</p> <p>Task Performed: Work on energized electrical conductors and/or parts of equipment directly supplied by a panelboard or motor control center.</p> <p>System Details: System Type: AC; Nominal System Voltage/Phase to phase: 120 V / 208 V; Voltage to which Personnel will be Exposed: 120 V / 208 V</p> <p>Shock Protection and Arc Flash Boundary: This is not an acceptable energized electrical work permit. The supplied data exceeds the limits of permission of table 130.2(C)(2) and 130.2(C)(3) of NETA 70E, 2015 edition. These tables and this permit cannot be used. The 2015 edition of NETA 70E article 130.2(C) dictates that if table per analysis are exceeded on incident energy calculations to require a low-hazard Category Method should not be used.</p> <p>Review By Electrically Qualified Person: [Blank]</p>
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ENERGIZED ELECTRICAL WORK PERMIT 130.2(B) (2)

- A description of the circuit and equipment to be worked on- and the equipment location
- Description of the work to be performed
- **Justification for why the work must be performed in an energized condition**
- A description of the safe work practices to be employed
- **Results of the shock hazard analysis (130.4)**
- **Results of the arc flash hazard analysis (130.5)**
- Means to restrict unqualified persons from the area
- Evidence of completion of job briefing
- **Approval to proceed**

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EXEMPTIONS TO WORK PERMIT 130.2(B)

Work performed **within the limited approach boundary of energized electrical conductors** or parts related to tasks such as:

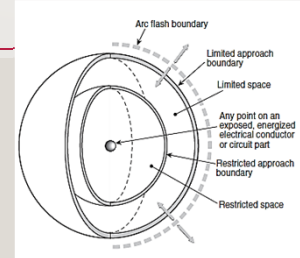
- testing, troubleshooting, voltage measuring, etc.,
 - Thermography or ultrasound
 - Access to and from the area if no electrical work is being performed
 - General housekeeping if the restricted boundary is not crossed
- shall be permitted to be performed **without an energized electrical work permit**, provided safe work practices are followed.

130.3 WORKING WHILE EXPOSED TO ELECTRICAL HAZARDS

- The work practices used around live conductors must be consistent with the electrical hazards and the associated risk.
- Risk and work practices must be evaluated before work begins using **shock risk assessment and arc flash risk assessment.**
- Only qualified workers are permitted to work on circuits that are **not electrically safe.**

APPROACH BOUNDARIES

- Approach boundaries determine area where shock or electrocution may exist



APPROACH BOUNDARIES FOR SHOCK PROTECTION

- 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) **NEW** Estimate of Likelihood and Severity considering:
 - (1) the design of the equipment
 - (2) equipment condition and condition of maintenance
- 130.4 (C) Additional protective measures
- 130.4 (D) Documentation
- 130.4 (E) Shock protection Boundaries
- Table 130.4 (E) (a) for AC boundaries Table 130.4 (E) (b) for DC boundaries

130.4 LIMITED/ RESTRICTED APPROACH BOUNDARY

SHOCK BOUNDARY

- 130.4 (F) **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 persons** are 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

SHOCK HAZARDS

TABLE 130.4 (D) (a)- LIMITED /RESTRICTED APPROACH FOR AC

Table 130.4(D)(a) Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection for Altering Current Systems (All dimensions are distance from energized electrical conductor or circuit part to employee).

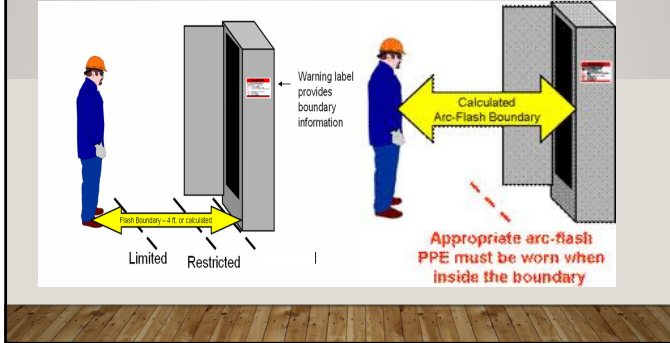
Nominal System Voltage Range, Phase to Phase ⁽¹⁾	Limited Approach Boundary ⁽²⁾		Restricted Approach Boundary ⁽²⁾ , Includes Insufficient Maintenance ⁽³⁾
	Exposed Moveable Conductor ⁽⁴⁾	Exposed Fixed Circuit Part	Not specified
<50 V	Not specified	Not specified	Not specified
50 V-150 V ⁽⁵⁾	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V-250 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.5 m (1 ft 8 in.)
251 V-480 V	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 4 in.)
481 V-725 V	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.8 m (2 ft 7 in.)
726 V-121 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.9 m (2 ft 10 in.)
122 kV-25 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.)
26 kV-121 kV	3.3 m (11 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.)
138 kV-145 kV	3.4 m (11 ft 2 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
161 kV-169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)
230 kV-242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 6 in.)
243 kV-362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)
363 kV-500 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 8 in.)
501 kV-800 kV	7.2 m (23 ft 6 in.)	7.2 m (23 ft 6 in.)	4.9 m (16 ft 1 in.)

Note (1) For air flash boundary, see 130.5(A).
 Note (2) All dimensions are distance from exposed energized electrical conductor or circuit part to the employee.
 Note (3) For single-phase systems above 250V, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
 Note (4) See definition in Article 100 and text in 130.4(D)(2) and Informational Annex C for elaboration.
 Note (5) Energized accessible conductors describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.
 Note (6) This includes circuits where the voltage does not exceed 120V.

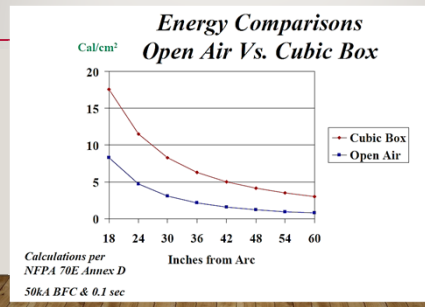
130.4 (G)

- If you take any conductive parts into the restricted approach space you must:
 - Be insulated for the hazard
 - The parts must be insulated where you might contact them
 - You must be insulated from other conductive parts

DISTANCES



ENERGY COMPARISONS



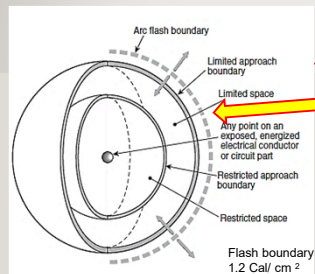
ARC FLASHES

Created by the electric arc – that is a 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 .1 second yields incurable burns

FLASH BOUNDARY



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

BASIC RISK ASSESMENT

- ## EQUIPMENT LABELING
- Equipment labeled 70E 130.5 (H)
 - **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

REQUIRED LABEL FOR 70E AND OSHA

WARNING

Arc Flash and Shock Hazard
 Appropriate PPE Required

24 inch	Flash Hazard Boundary
3	cal/cm ² Flash Hazard at 18 inches
1	PPE Level, 1 Layer 6 oz. Nomex, Leather Gloves Faceshield
480 VAC	Shock Hazard when Cover is removed
42 inch	Limited Approach
12 inch	Restricted Approach - 500 V Class 00 Gloves

Equipment Name: **MIDWEST**

INFORMATION ANNEX H: GUIDE TO PPE SELECTION

Two category system in Annex H simplifies clothing selection.

Table H.2
Refers to Category 1 or 2 requirements for 8 calorie arc rated shirts and pants or coveralls. Category 3 or 4 requires 40 calorie Arc flash suit

Table H.3
• Is a summary of different sections describing PPE requirements from head to foot.

Article H.4 in Annex H
Provides standards for PPE to maintain conformity with requirements as in Annex "A"

PLANT FLOOR LABEL

WARNING

Arc Flash and Shock Risk
 Appropriate PPE Required
 When Energized Parts Are Exposed

FLASH PROTECTION Arc Flash Hazard: 1.7 cal/cm² Arc Flash Hazard at: 18 in Arc Flash Boundary: 23 in <small>See Annex H.3(b) of NFPA-70E for required Protective Clothing (PPE).</small>	SHOCK PROTECTION Nominal Voltage: 480 VAC Limited Approach: 42 in Restricted Approach: 12 in Glove Class: 00 Available SC Current: 1.48 kA DYMAX Engineering May 07, 2015
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Loc: **EXTRUSION DC DRIVE FSW**

PLANT FLOOR LABEL

DANGER

Arc Flash and Shock Risk
 Appropriate PPE Required
 When Energized Parts Are Exposed

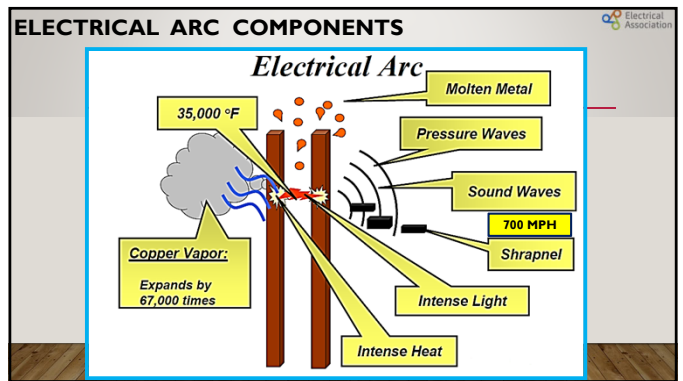
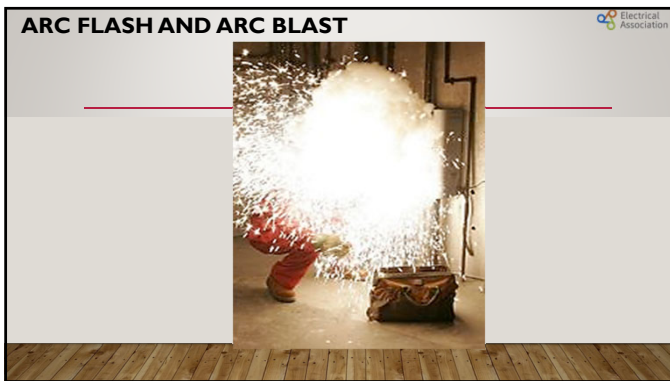
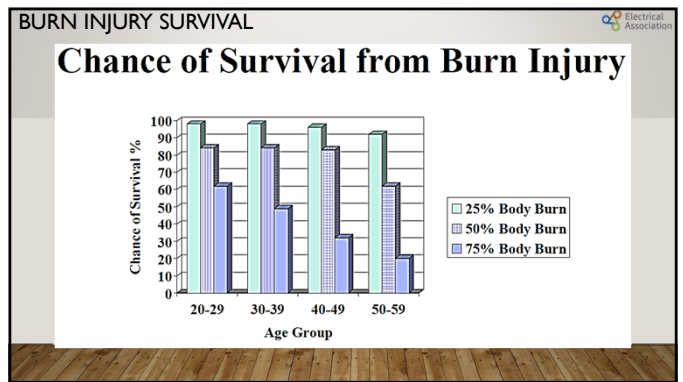
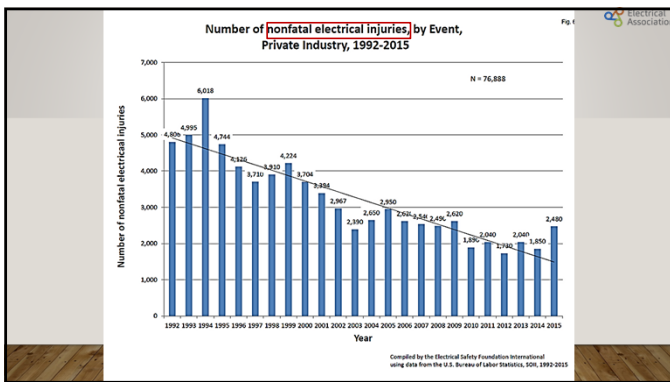
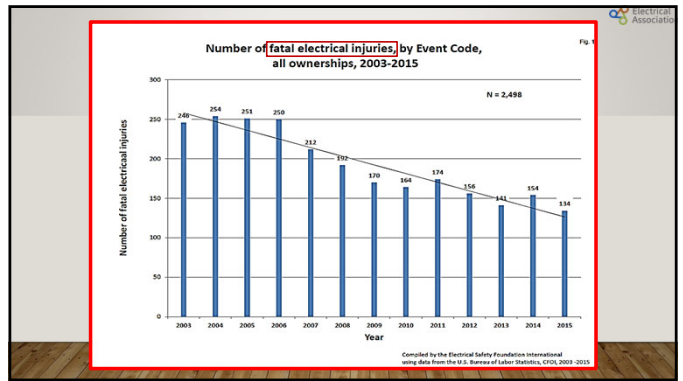
FLASH PROTECTION Arc Flash Hazard: 70 cal/cm² Arc Flash Hazard at: 18 in Arc Flash Boundary: 216 in <small>See Annex H.3(b) of NFPA-70E for required Protective Clothing (PPE).</small>	SHOCK PROTECTION Nominal Voltage: 480 VAC Limited Approach: 42 in Restricted Approach: 12 in Glove Class: 00 Available SC Current: 21.13 kA DYMAX Engineering May 07, 2015
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Loc: **MS-2A**

CDC - NIOSH: PERFORM LOCK-OUT, TAG-OUT



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

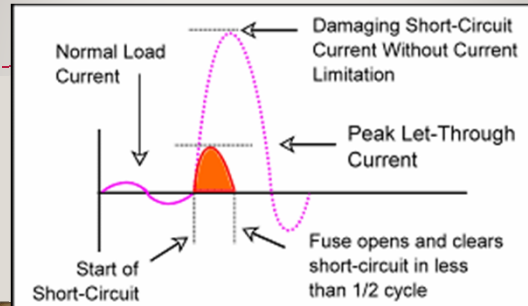



TIME AND CURRENT RATINGS



- The **amount of time** that the overcurrent protection allows current to flow, directly correlates to the amount of arc energy. Dependent on the **speed of interruption** of the fault current. E.g.: fast acting
- The **amount of current** allowed to flow during the arc fault directly correlates to the amount of arc energy. Dependent on the type of overcurrent protection current limits. E.g.: Current limiting

CURRENT LIMITING FUSE – LET THROUGH



EXCEEDING INTERRUPTING RATING



The picture below illustrates how 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 cabinet

INCIDENT ENERGY



OTHER ARC FLASH SAFETY CONSIDERATIONS



- Stay alert- not distracted
- Do not work impaired- fatigue, sick, drugs
- The situation and scope of work may change
- Reaching in blind
- Doors are secured
- Work is adequately illuminated
- Your view of the work is obstructed
- You are wearing conductive objects
- Conductive tools and equipment
- Confined space work
- Defeated Safety interlock
- Resetting of tripped circuits

70E 130.7 PPE



- PPE is to be maintained in a safe, reliable and clean condition.
- Eye Protection must be worn- Eye and face protection equipment should meet requirements specified by the American National Standards Institute Z87.1: Practice for Occupational and Educational Eye and 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)

- 130.4 for clothing when working within the restricted approach boundary
- 130.5(G) for clothing within the arc flash boundary (Using the incident energy calculations)
- 130.5(H) Equipment Labeling

PERSONAL PROTECTIVE EQUIPMENT (PPE)

- 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 and 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

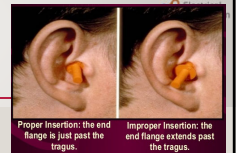
PERSONAL PROTECTIVE EQUIPMENT (PPE)

- **Hard Hat Voltage Insulation Protection Comparison**
- **Class G (old Class A)** hard hats protect from electric shock by voltages up to 2,200 volts.
- **Class E (old Class B)** hard hats protect from electric shock by voltages up to 20,000 volts.
- **Class C hardhats provide impact protection but NO protection from electrical hazards.**



PPE

- Hearing protection must be worn
- Body protection needs rated clothing including rainwear
- Acetate, nylon, polyester, spandex shall Not be next to the skin –underwear...
- Rubber Insulated gloves (Shock protection) with leather protectors (minimum .03” thickness) (thermal protection) - Heavy duty leather gloves or arc rated gloves to be used for flash protection
- Rubber sleeves where needed
- Foot Protection: dielectric footwear where step and touch potential is present Heavy duty leather shoes are required for over 4 cal/ cm²



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. Not required if using a flash hood
- A hood is required if the incident energy is over 12cal/cm²

Balaclava (Revised Definition 2021)
 “An arc-rated head-protective fabric that protects the neck and head except for a small portion of the facial area”



CLASS OF GLOVE – RATINGS PHASE TO GROUND OR PHASE TO PHASE IF CLOSE QUARTERS

Class Color	Proof Test Voltage AC / DC	Max. Use Voltage* AC / DC	Rubber Molded Products Label	Glove Label	Rubber Dipped Sleeve Label
00 Blue	2,500 / 10,000	500 / 750			
0 Red	5,000 / 20,000	1,000 / 1,500			
1 White	10,000 / 40,000	2,500 / 11,250			
2 Yellow	20,000 / 80,000	17,500 / 25,000			
3 Green	30,000 / 100,000	25,000 / 37,500			
4 Orange	40,000 / 170,000	30,000 / 54,000			

Insulating Gloves and Sleeves must have a color coded label to meet appropriate ASTM Specifications.
 *Max. Use Voltage when worn with leather protectors.


SALISBURY GLOVES AND SLEEVES

GENERALLY INSPECT (HAND ROLL) EVERY USE

INSPECT BEFORE USE AND EVERY 12 MONTHS




INSULATED GLOVES



- Gloves to be tested before first issue and every 6 months thereafter . Check for every use

WORKING LIVE



ANYTHING YOU WOULD DO DIFFERENTLY?

RATING FLAME RESISTANT VS ARC RESISTANT

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. Which ever point is reached first is rated in cal/ cm²

- 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

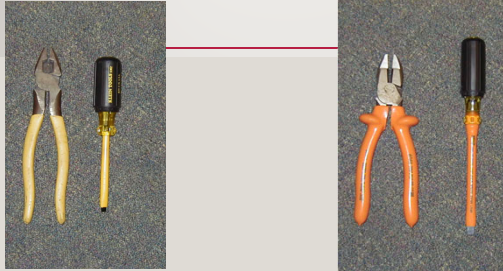
Arc rating and flame resistant are two different things but are often confused because they go together. You can't have an arc rating without the material being flame resistant. According to the arc rating standards (ASTM F1506, ASTM F1959, IEC 61482-2, IEC 61482-1-1 Method A and IEC 61482-1-1 Method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


RATED FOR VOLTAGE USED ON




Not insulated Electrically insulated

130.7

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




Ropes and handlines used within the Limited Approach boundaries shall be non-conductive. Fiberglass reinforced plastic push rods are considered non-conductive.



- 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



SAFETY BARRICADES 130.7(E) 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

PPE:



Hazard Risk Category 1	Hazard Risk Category 2	Hazard Risk Category 3	Hazard Risk Category 4
------------------------	------------------------	------------------------	------------------------

CAT III 600V METERS



Overvoltage category	In brief	Examples
CAT IV	Three-phase at utility connection, any outdoor conductors	<ul style="list-style-type: none"> Refers to the "origin of installation," i.e., where low-voltage connection is made to utility power Electricity meters, primary overcurrent protection equipment Outside and service entrance, service drop from pole to building, run between meter and panel Overhead line to detached building, underground line to well pump
CAT III	Three-phase distribution, including single-phase commercial lighting	<ul style="list-style-type: none"> Equipment in fixed installations, such as switchgear and polyphase motors Bus and feeder in industrial plants Feeders and short branch circuits, distribution panel devices Lighting systems in larger buildings Appliance outlets with short connections to service entrance
CAT II	Single-phase receptacle connected loads	<ul style="list-style-type: none"> Appliance, portable tools, and other household and similar loads Outlet and long branch circuits Outlets at more than 10 meters (30 feet) from CAT III source Outlets at more than 20 meters (60 feet) from CAT IV source

INDUCTORS


- Stored electrical energy in an electromagnetic field
- Motors, transformers use coils
- If energized with DC will produce an electromagnetic discharge or "inductive kick" when discharged

CDC - NIOSH: STATISTICS

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH



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



ELECTROCUTION WAS THE 4TH LEADING CAUSE OF DEATH ON CONSTRUCTION SITES IN 2018

THIS CONCLUDE THE CLASS

OSHA / 70E – 2021 EDITION

ELECTRICAL TRAINING

BY

ELECTRICAL ASSOCIATION

THANK YOU FOR YOUR ATTENDANCE AND PARTICIPATIONS