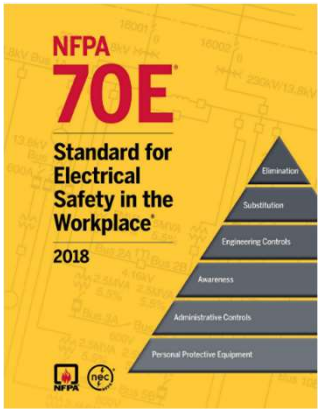
NFPA 70E 2018

Key Elements and Updates



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Services We Provide

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- Safety Consulting, Training, and Compliance
- Lockout/Energy Control Procedure Development
- Electrical Safety Audits and Training
- Incident Energy Analysis (Arc Flash Labeling)
- Confined Space Assessments and Procedures
- Fall Hazard Identification and Assessments
- On-Site Safety Training to the Authorized, Competent, and/or Qualified Person Level

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Objectives

- NFPA 70E…Arc Flash and Shock Hazards
- Qualified Persons…who are they?
- Responsibilities of a workplace

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NFPA 70E and OSHA

- NFPA *70E* arose from the need to address the electrical safety of employees when they are interacting with electrical equipment in a manner other than under normal operation.
- OSHA has a **General Duty Clause**, Section 5(a)(1)…employer must furnish a workplace that is free from recognized hazards causing or likely to cause death or serious physical injury.
- OSHA looks to NFPA *70E* to fill out the performance based requirements included in their standards.

Electrical Accidents

Caused by a combination of these three factors:

1. Unsafe equipment and/or installation,
2. Workplaces made unsafe by the environment, and
3. Unsafe work practices.

There are various ways of protecting people from the hazards caused by electricity. These include: insulation, guarding, grounding, electrical protective devices, and safe work practices.

Unsafe Equipment

Dead front cover missing

Breaker Compromised

Leaking Roof – Water in Panel

Damaged Panels

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Electrical Safety Compliance
What is a company to do…

1. Provide and demonstrate an Electrical Safety Program with defined responsibilities, risk assessment requirements
2. Determine the Arc Flash & Shock Hazard Levels
3. Provide training on the hazards and ensure employees **demonstrate** proficiency
4. Provide employees with and ensure the proper usage of PPE and Tools
5. Warning labels on equipment

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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.

- Also familiar with the proper use of:
  - special precautionary techniques
  - applicable electrical policies and procedures
  - PPE, insulating and shielding materials
  - insulated tools and test equipment.

A person can be considered qualified for certain equipment and methods but not qualified for others.

Qualified Persons…Training

Qualified employees required to work within the **Limited Approach Boundary** of exposed parts operating at **50 volts** or more shall be additionally trained in all of the following:

1. Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment;
2. Skills and techniques necessary to determine nominal voltage of exposed energized parts;
3. Safe approach distances and corresponding voltages to which the qualified employee will be exposed; and
4. Process required to determine the degree and extent of the hazard, PPE and job planning necessary to perform the task safely.

Test Instrument Training

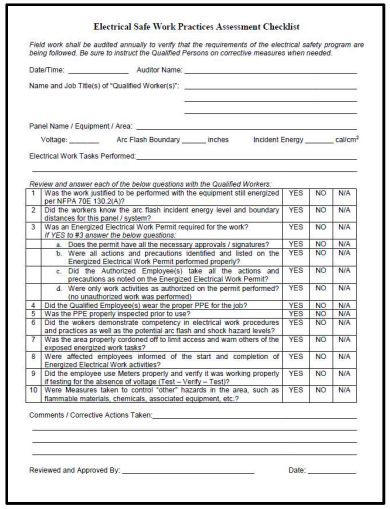
- Employees shall be trained to select an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device.
- The training shall include information that enables the employee to understand all limitations of each test instrument that might be used.

Emergency Response Training

- **Contact Release.** Employees exposed to 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.
- Refresher training shall occur annually.

Annual Inspections

- The employer shall determine through regular supervision or through inspections conducted **on at least an annual basis** that each employee is complying with the safety-related work practices required by this standard.



Electrical Safe Work Practices Assessment Checklist

Field work shall be audited annually to verify that the requirements of the electrical safety program are being followed. Be sure to instruct the Qualified Persons on corrective measures when needed.

Date/Time: _____ Auditor Name: _____

Name and Job Title(s) of "Qualified Worker(s)": _____

Panel Name / Equipment / Area: _____

Voltage: _____ Arc Flash Boundary _____ inches Incident Energy _____ cal/cm²

Electrical Work Tasks Performed: _____

Review and answer each of the below questions with the Qualified Workers:

1	Was the work justified to be performed with the equipment still energized per NFPA 70E 130.2A)?	YES	NO	N/A
2	Did the workers know the arc flash incident energy level and boundary distances for this panel / system?	YES	NO	N/A
3	Was an Energized Electrical Work Permit required for the work? *If YES to #3 answer the below questions:*	YES	NO	N/A
	a. Does the permit have all the necessary approvals / signatures?	YES	NO	N/A
	b. Were all actions and precautions identified and listed on the Energized Electrical Work Permit performed properly?	YES	NO	N/A
	c. Did the Authorized Employee(s) take all the actions and precautions as noted on the Energized Electrical Work Permit?	YES	NO	N/A
	d. Were only work activities as authorized on the permit performed? (no unauthorized work was performed)	YES	NO	N/A
4	Did the Qualified Employee(s) wear the proper PPE for the job?	YES	NO	N/A
5	Was the PPE properly inspected prior to use?	YES	NO	N/A
6	Did the wokers demonstrate competency in electrical work procedures and practices as well as the potential arc flash and shock hazard levels?	YES	NO	N/A
7	Was the area properly cordoned off to limit access and warn others of the exposed energized work tasks?	YES	NO	N/A
8	Were affected employees informed of the start and completion of Energized Electrical Work activities?	YES	NO	N/A
9	Did the employee use Meters properly and verify it was working properly if testing for the absence of voltage (Test – Verify – Test)?	YES	NO	N/A
10	Were Measures taken to control "other" hazards in the area, such as flammable materials, chemicals, associated equipment, etc.?	YES	NO	N/A

Comments / Corrective Actions Taken: _____

Reviewed and Approved By: _____ Date: _____

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Retraining Requirements

- Intervals not to exceed **3 years**.
- An employee shall receive additional training (or retraining) if any of the following exists.

1. The supervision or annual inspections indicate the employee is not complying with the safety-related work practices.
2. New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices different from those that the employee would normally use.
3. The employee needs to review tasks that are performed less often than once per year.
4. The employee needs to review safety-related work practices not normally used by the employee during regular job duties.
5. The employee's job duties change.

Risk Assessment

An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.

Two Risk Assessments per NPFA 70E

- Arc Flash risk assessment
- Shock Hazard risk assessment

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Shock Hazard Analysis

- Shall be performed to determine
  - Voltage personnel will be exposed
  - Boundary requirements
  - Personal protective equipment

SHOCK APPROACH BOUNDARIES

- **Limited Approach Boundary:**
  may not be crossed by an “unqualified” person unless accompanied by “qualified” persons
- **Restricted Approach Boundary:**
  Crossed only by “qualified” persons, Use PPE that is appropriate for working near exposed energized parts

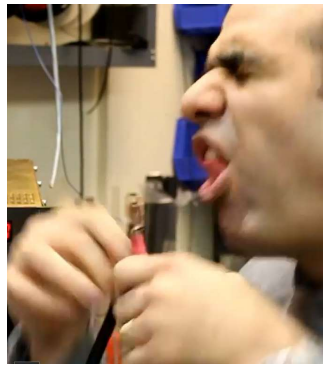
Use NFPA 70E Table 130.4(D)(a) and (b) to determine SHOCK protection boundaries

Dangers of Electrical Shock

1-10-100 Rule:

- 1ma tingle, 10ma cant let go, 100ma DEATH

How Current Affects the Human Body



- Using Ohms Law V=I*R or V/R=I
- Finger Touch in Dry Conditions:
  - 480V / 70,000ohms = 6.8mA
    Shock…Can Let Go
- Finger Touch in Wet Conditions:
  - 480V / 5,000ohms = 96mA
    Sufficient to cause respiratory paralysis, cardiac arrest, death is possible

Shock Approach Boundaries

NFPA 70E Shock Hazard ALTERNATING Current AC Table

Nominal System Voltage Range Phase to Phase[a]	Limited Approach Boundary[b]		Restricted Approach Boundary[b]
	Exposed Moveable Conductor[c]	Exposed Fixed Circuit Part	
Less than 50	Not specified	Not specified	Not specified
50V to 150V[d]	10 ft	42 inches	Avoid Contact
151V to 750V	10 ft	42 inches	12 inches
751V to 15kV	10 ft	60 inches	26 inches
15.1 to 36kV	10 ft	72 inches	31 inches
36.1 to 46kV	10 ft	96 inches	33 inches

a. For single-phase systems above 250V, select the range that is equal to the system's maximum phase-toground voltage multiplied by 1.732.
b. See definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.
c. *Exposed movable 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.
d. This includes circuits where the exposure does not exceed 120V.

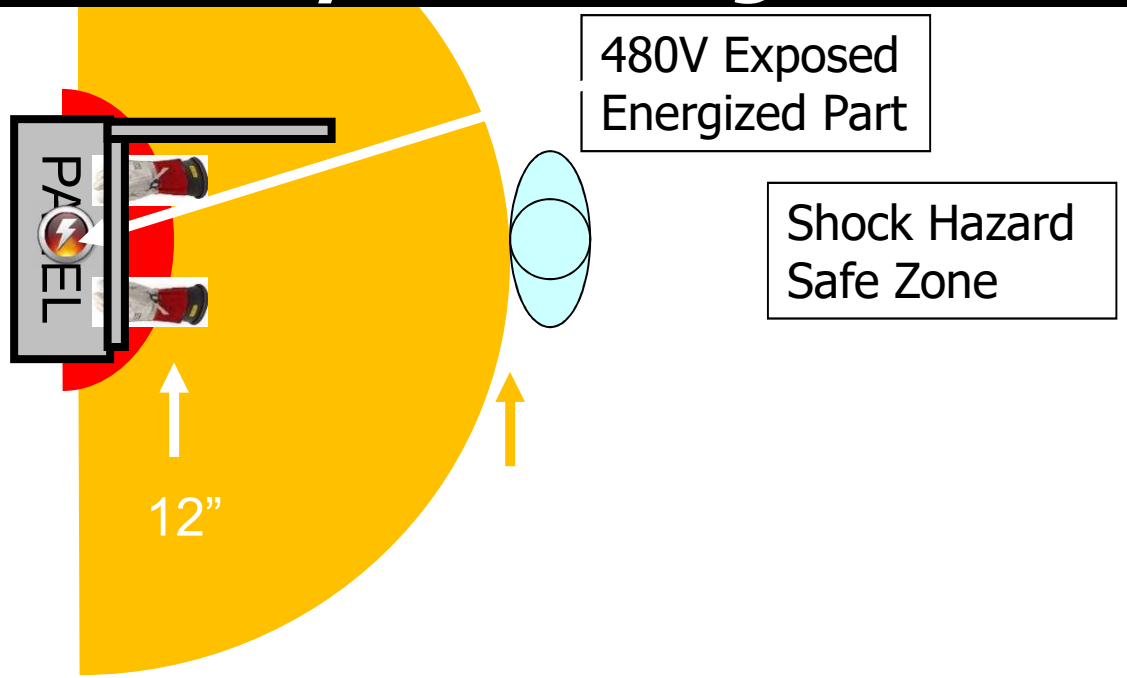
Shock Approach Boundaries

NFPA 70E Shock Hazard DIRECT Current (DC) Table

Voltage; Nominal Potential Difference	Limited Approach Boundary		Restricted Approach Boundary
	Exposed Moveable Conductor	Exposed Fixed Circuit Part	
Less than 50V	Not specified	Not specified	Not specified
50V to 300V	10 ft	42 inches	Avoid Contact
301V to 1kV	10 ft	42 inches	12 inches
1.1 kV to 5 kV	10 ft	60 inches	17 inches
5 kV to 15 kV	10 ft	60 inches	26 inches
15.1 to 150 kV	10 ft	96 inches	33 inches

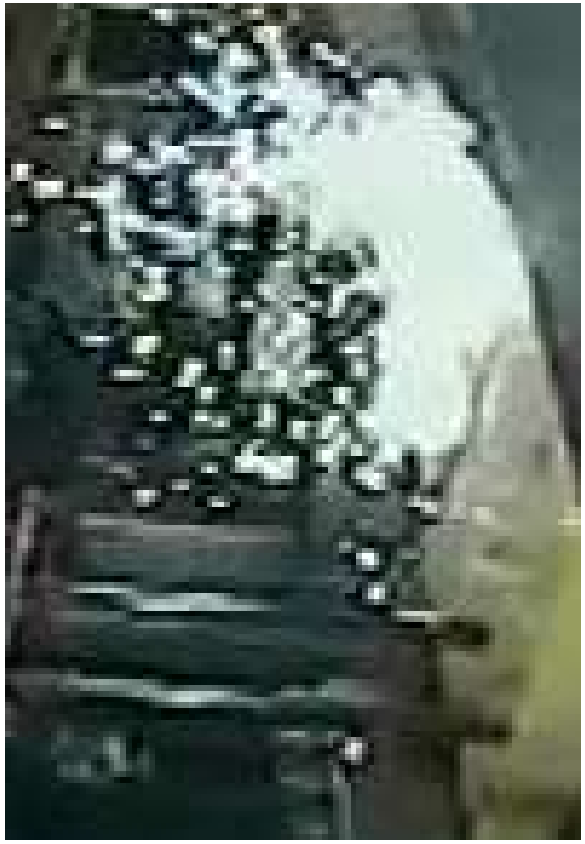
Shock Approach Boundaries

*Distances From **Exposed Energized** Parts*



	Restricted	**Limited**
Qualified Persons	No conductive objects, rubber gloves, VR tools	OK
Unqualified Persons	Not under any circumstances	Only with qualified escort

Arc Flash Hazard



Open Panel Interacting with Equipment

Closed Panel Interacting with Equipment

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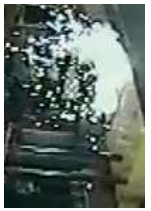
Arc Flash Hazard



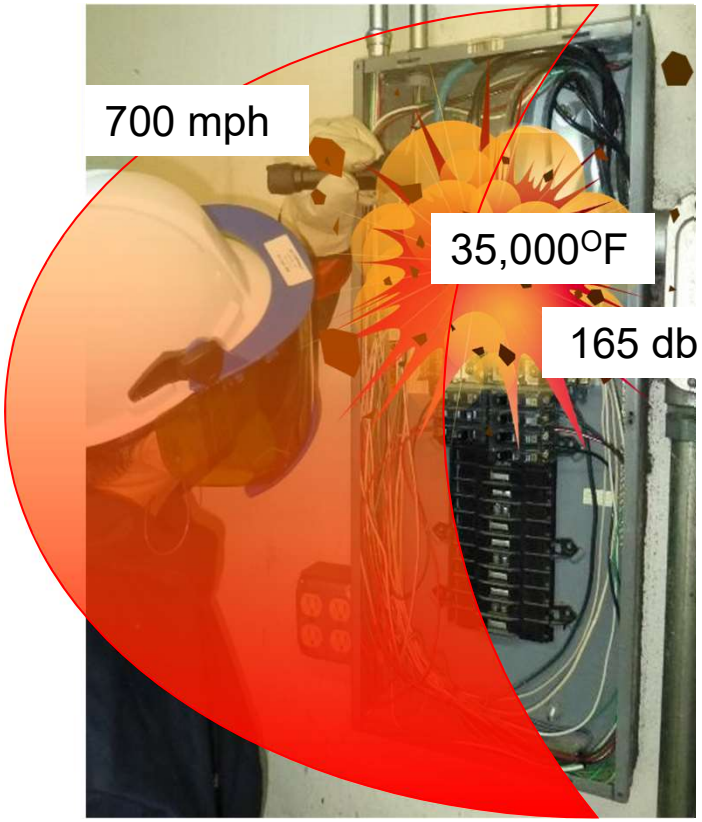
A source of possible injury or damage to health associated with the release of energy caused by an electric arc.

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are **exposed** or when they are within equipment in a guarded or **enclosed** condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained.

Informational Note No. 2: See Table 130.5(C) for examples of tasks that increase the likelihood of an arc flash incident occurring.

Arc Flash Boundary

- Radiant energy explodes outward from electrical equipment
- Shrapnel hurling at up to 700 MPH
- Up to 35,000°F, three times hotter than the surface of the sun.



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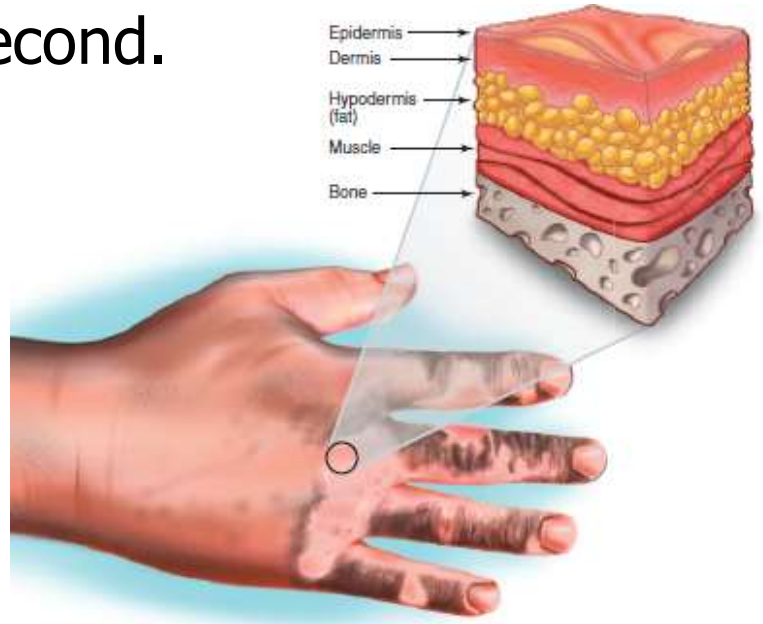
Arc Flash Boundary

When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals **1.2 cal/cm^2 (5 J/cm^2).**

Informational Note: According to the Stoll skin burn injury model, the onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm^2 (5 J/cm^2) for one second.



Arc Flash Risk Assessment

An arc flash risk assessment shall be performed:

(1) To identify arc flash hazards

(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health

(3) To determine if additional protective measures are required, including the use of PPE

Estimate of Likelihood of Occurrence

Table 130.5(C) is used to estimate the likelihood of occurrence of an arc flash event to determine if additional protective measures are required.

Based on the following items:

- Task Being Performed
- Equipment Condition (Normal or Abnormal)
- Likelihood of Occurrence (Yes or No)

Was Table 130.7(C)(15)(A)(a) in NFPA 70E 2015

TABLE 130.5(C) *Continued.*

Task	*Equipment Condition*	*Likelihood of Occurrence**
Operation of a CB, switch, contactor, or starter. Voltage testing on individual battery cells or individual multi-cell units. Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts. Opening a panelboard hinged door or cover to access dead front overcurrent devices. Removal of battery nonconductive intercell connector covers.	Normal	No
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack Insertion or removal of individual cells or multi-cell units of a battery system in an open rack. Arc-resistant switchgear Type 1 or 2 (for clearing times of less than 0.5 sec with a prospective 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. Insertion or removal (racking) of CBs from cubicles; Insertion or removal (racking) of ground and test device; or Insertion or removal (racking) of voltage transformers on or off the bus. Equipment condition considered to be "normal" if all of the following circumstances apply:	Abnormal	Yes

Excerpt of Table 130.5(C)

Equipment condition considered to be "normal" if all of the following circumstances apply:

(1) The equipment is properly installed in accordance with the manufacturer's recommendations and applicable industry codes and standards.
(2) The equipment is properly maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards.
(3) The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
(4) Equipment doors are closed and secured.
(5) Equipment covers are in place and secured.
(6) There is no evidence of impending failure such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

TABLE 130.5(C) *Guidance*

- Where this table identifies "No" as an estimate of likelihood of occurrence, it means that an arc flash incident is **not likely** to occur.
- Where this table identifies "Yes" as an estimate of likelihood of occurrence, it means that additional protective measures are required to be selected and implemented according to the hierarchy of risk control.

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

Selecting Arc Flash PPE

One of the following methods shall be used for the selection of arc flash PPE:

(1) The incident energy analysis method

(2) The arc flash PPE category method

Either, but not both, methods shall be permitted to be used on the same piece of equipment.

OPTION 1

Incident Energy Analysis Method "Arc Flash Study"

- The incident energy analysis shall take into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance.
- The incident energy analysis shall be updated when changes occur in the electrical distribution system that could affect the results of the analysis.
- The incident energy analysis shall also be reviewed for accuracy at intervals not to exceed **5 years**.

Use **Table 130.5(G) For PPE when using this method*

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Incident Energy Analysis

- On-Site Data Collection
  - Fuses/Breakers
  - Wire Sizes/Types
  - Transformers
  - Loads / Motor Size
- Electrical One-Line
- Analysis
  - Short Circuit Study
  - Arc Flash Energy (cal/cm^2)
  - Arc Flash Boundary
- Recommendations
- Improvements

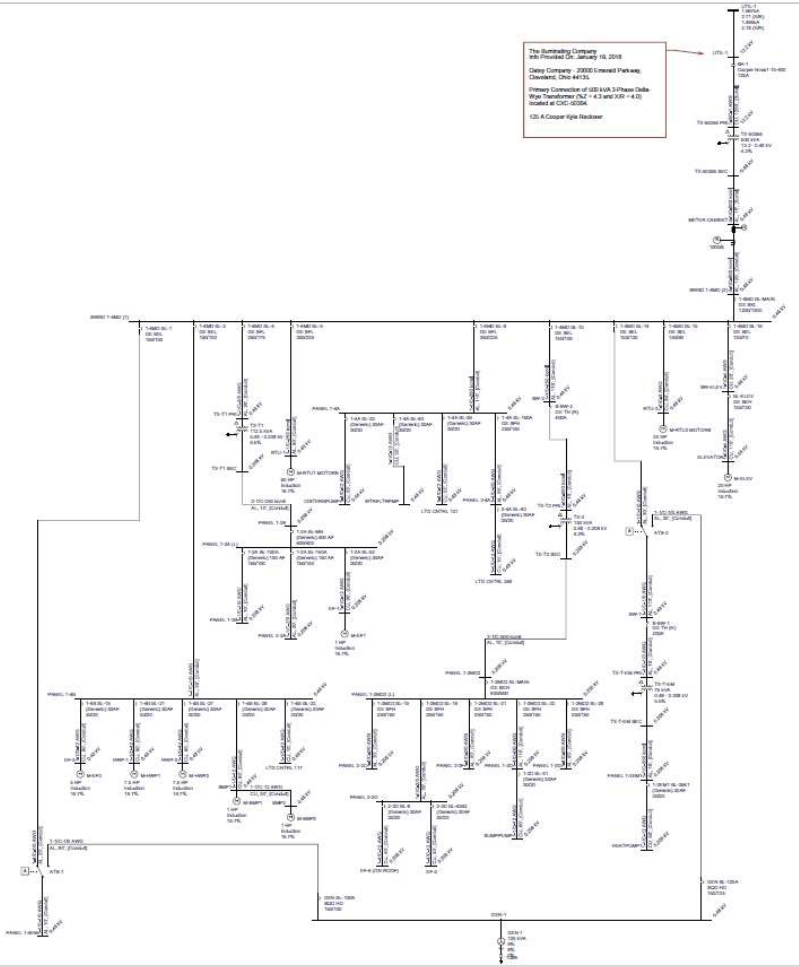

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Table 130.5 (G) – Arc Flash PPE

This table identifies the arc-rated clothing and other PPE requirements, used with the **incident energy analysis method.**

- No longer PPE specified for less than 1.2 cal/cm^2
- PPE for 1.2 cal/cm^2 to 12 cal/cm^2

- PPE for greater than 12 cal/cm^2

Arc Hazard (10.4 cal/cm^2 Arc)

No Arc-Rated PPE

Arc-Rated PPE

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OPTION 2

Arc Flash PPE Category Method

This entails using Tables within NFPA70E to determine the PPE Level and Arc-Flash Boundary based on Type of Equipment you will be interacting with.

TABLE 130.7(C)(15)(a) *Arc-Flash PPE Categories for AC*

TABLE 130.7(C)(15)(b) *Arc-Flash PPE Categories for DC*

Partial Table Below:

TABLE 130.7(C)(15)(a) *Arc-Flash PPE Categories for Alternating Current (ac) Systems*

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)

TABLE 130.7(C)(15)(c) - Arc Flash PPE

Different Table used to determine PPE

- **LEVEL 0 – no longer exists**
- **LEVEL 1:** minimum of 4 cal/cm^2 rated PPE

- **LEVEL 2:** minimum of 8 cal/cm^2 rated PPE

- **LEVEL 3:** minimum of 25 cal/cm^2 rated PPE
- **LEVEL 4:** minimum of 40 cal/cm^2 rated PPE

What Needs to Be Labeled?

130.5(H) Equipment Labeling: Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling units and that are likely to require examination, adjustment, servicing, or maintenance while energized shall be marked with a label containing all the following information

(1) Nominal system voltage

(2) Arc flash boundary

(3) At least one of the following:

a. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) for the equipment, but not both

b. Minimum arc rating of clothing

c. Site-specific level of PPE

Sample Label

WARNING

Arc Flash and Shock Hazard
Appropriate PPE Required

System Voltage Level:	480 VAC	
Arc Flash Boundary:	5.6	inches
Incident Energy at 18 inches:	0.2	cal/cm^2

Shock Hazard Exists When Cover is Removed/Opened

Limited Approach Boundary:	42 Inch
Restricted Approach Boundary:	12 inch - 500V Class 00 Glove

COMP AIR
Trip Device: MDPE BL-MAIN

Label #: 16
12/29/2015

Label Must Have: Voltage, Arc Flash Boundary, Incident Energy or PPE Level

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Job Safety Planning

Before starting each job that involves exposure to electrical hazards, the employee in charge shall complete a job safety plan and conduct a job briefing with the employees involved.

Be completed by a **qualified person**; Be documented; Include the following information:

A description of the job and the individual tasks; Identification of the electrical hazards associated with each task; A shock risk assessment in accordance with 130.4 for tasks involving a shock hazard; An arc flash risk assessment in accordance with 130.5 for tasks involving an arc flash hazard; Work procedures involved, special precautions, and energy source controls

Electrical Safety Auditing

(1) Electrical Safety Program Audit: 3 years

(2) Field Work Audit: 1 Year

(3) Lockout/Tagout Program and Procedure Audit. The lockout/tagout program and procedures shall be audited by a qualified person at intervals not to exceed 1 year.

periodic inspections OSHA 1910.147

(4) Documentation: shall be documented

When Can Energized Work Be Allowed?

1. **Additional Hazards or Increased Risk.**

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

2. **Infeasibility.** Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

3. **System Operates at Less Than 50 Volts.**

4. **Normal Operation:** All the following are met;
   - The equipment is properly installed & maintained
   - Used in accordance with instructions and listing/labeling
   - Equipment covers/doors are in place and secured
   - No evidence of impending failure.

Energized Electrical Work Permit

- When energized work is permitted in accordance with 130.2(A), an energized electrical work permit shall be required under the following conditions:
  - When work is performed within the restricted approach boundary
  - 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.

ENERGIZED ELECTRICAL WORK PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER:

Job/Work Order Number_____

1) Description of circuit/equipment/job location_____

_____

2) Description of work to be done: _____

_____

3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:

_____

_____ _____

Requester/Title Date

PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS DOING THE WORK:

Check when

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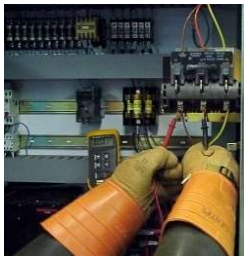
Permit Is NOT Required For…



130.2(B)(3) **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 under any of the following conditions:

1. Testing, troubleshooting, and 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

When Is the **Electrically Safe Work Condition** Required?

Unless the work task is allowed per 130.2(A) and 130.2(B)(3), the following would apply:

- Energized electrical conductors and circuit parts 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.

Electrically Safe Work Condition

- A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

END OF SESSION

- QUESTIONS AND ANSWERS

- THANK YOU!

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