

BRANDON AND CLARK INC. // SCOTT W. CLARK, P.E.

ELECTRICAL

CONTINUING EDUCATION

ARC FLASH - NFPA 70E

- Training is not a substitute for following corporate safety guidelines.
- Always refer to the latest safety standards when selecting PPE or evaluating hazards.

- “What is an electrical arc flash?”
- “How do I calculate the danger posed by an arc flash?”
- “How do I protect myself and others from an arc flash?”

TYPES OF ELECTRICAL FAULTS

Bolted Fault:

Bolted faults are characterized by a solidly connected fault path causing high levels of current to flow through this solid connection.



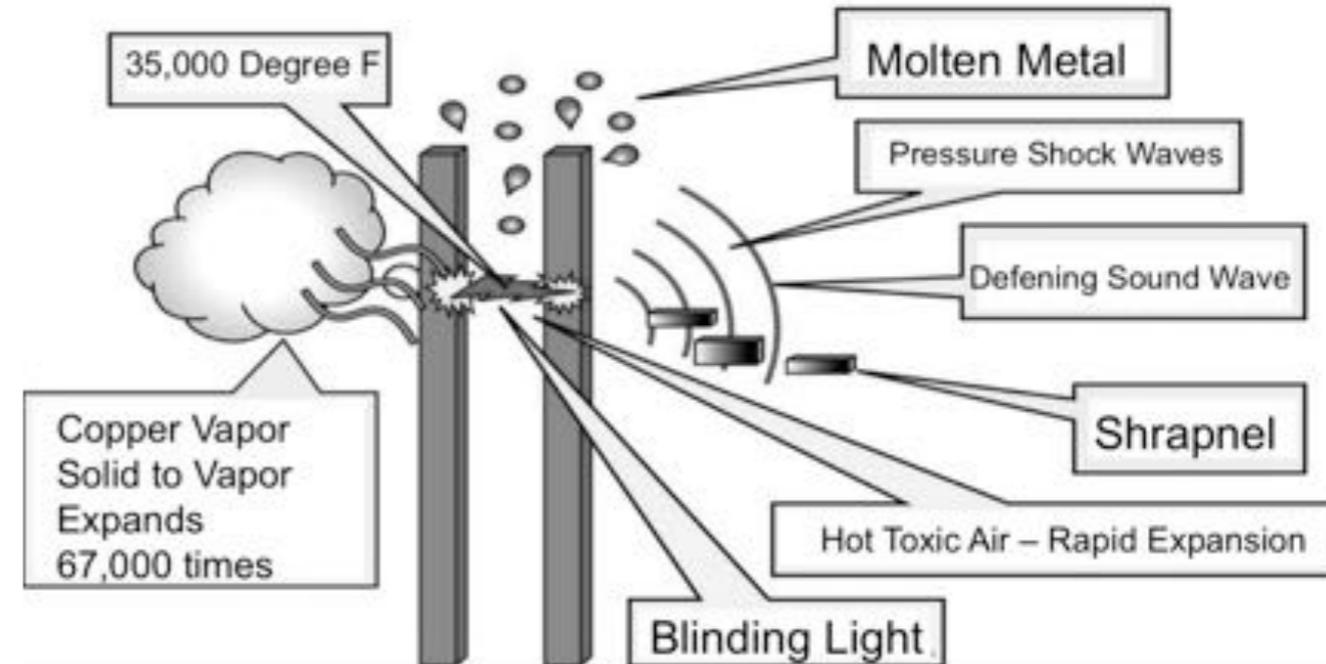
Arcing Fault:

Arcing faults differ in the fact that the current actually flows through ionized air causing an arc.



ELECTRICAL ARC FLASH

- Flash Temperature:
up to 35000 [°F]
- Blast Pressure:
500 to 600 [psi]
- Pressure Wave Velocity:
5500 to 6000 [ft/s]



ELECTRICAL ARC FLASH

- Injuries
- 2nd Degree Burn:
176[°F] @ 0.1[s]
- 3rd Degree Burn:
205[°F] @ 0.1[s]
- Threshold for 2nd Degree
Burn: 1.2 [cal/cm²]



ELECTRICAL ARC FLASH

Causes of arcing faults:

- Accidents caused by touching a test probe to the wrong surface.
- Accidental tool slippage.
- Sparks due to breaks or gaps in insulation system.
- Equipment failure due to use of substandard parts, improper installation, or even normal wear and tear.
- Dust, corrosion or other impurities on the surface of the conductor insulation systems.



ELECTRICAL ARC FLASH

- 5 to 10 arc flash explosions occur in electric equipment every day in the United States.
- This number does not include cases in which the victim is sent to an ordinary hospital.
- These incidents are so severe the victims require treatment from a special burn center.



ELECTRICAL ARC FLASH HAZARD

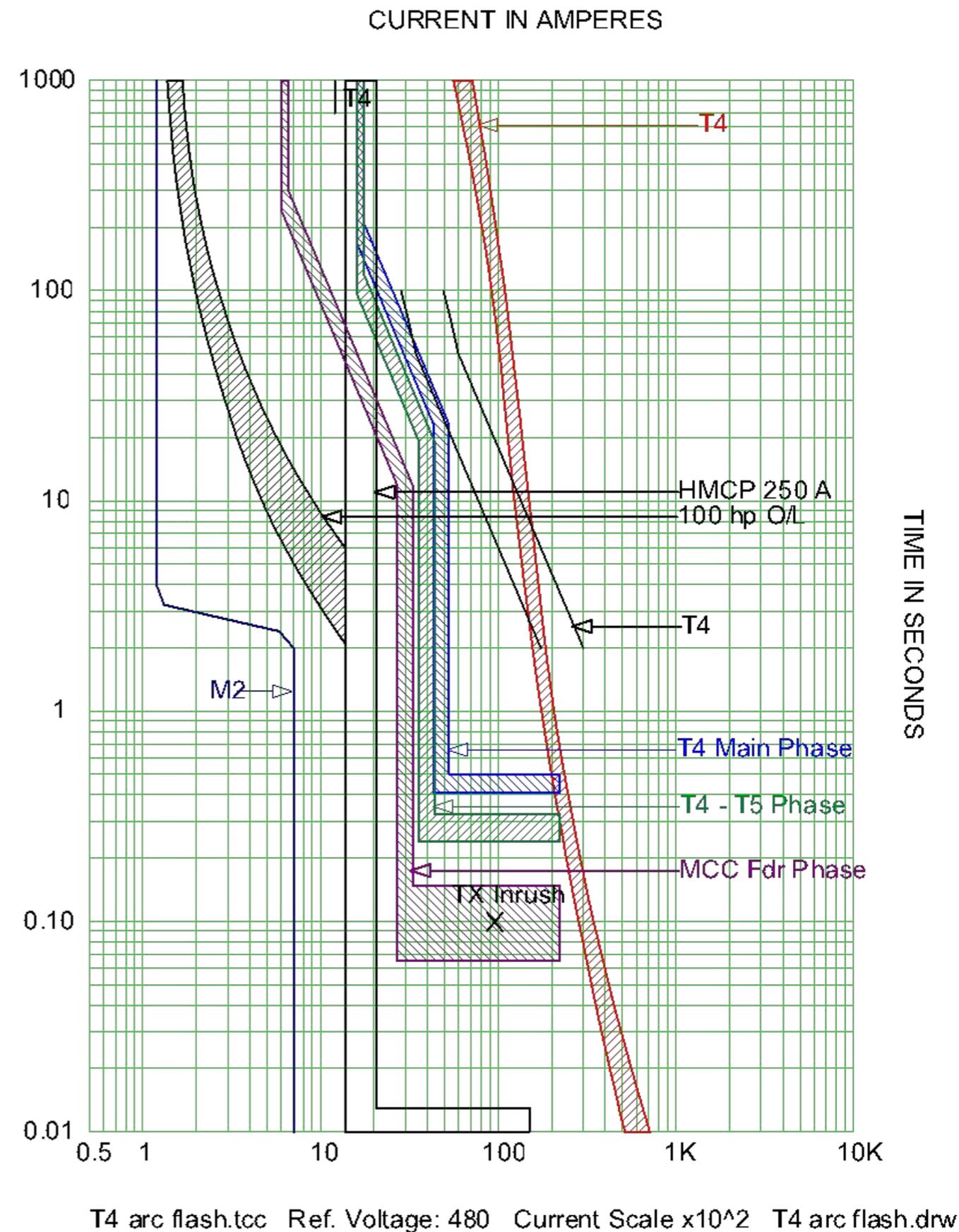
- NFPA 70E
- Arch Flash Hazard: A dangerous condition associated with the possible release of energy caused by an electric arc
- FPN No.1: "...may exist when energized electrical conductors are exposed... a person interacting with equipment in such a manner that could cause an electric arc."



- “What is an electrical arc flash?”
- “How do I calculate the danger posed by an arc flash?”
- “How do I protect myself and others from an arc flash?”

ELECTRICAL ARC FLASH HAZARD

- Arc Flash Hazard Analysis: A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash protection boundary, and appropriate levels of PPE.
- Calculations based on NFPA Annex D



ELECTRICAL ARC FLASH HAZARD

- Arc Flash Hazard Analysis Results:
- PPE Selection
- Arc Flash Boundary



WARNING

Arc Flash & Shock Hazard Appropriate PPE Required

FLASH PROTECTION	SHOCK PROTECTION
Flash Hazard Category: <u>0</u>	480 VAC Shock Hazard When: COVER IS OPENED OR REMOVED
Min. Arc Rating (cal/cm2): <u>0.96</u>	Limited Approach Boundary: <u>42"</u>
Flash Protection Boundary: <u>11"</u>	Restricted Approach Boundary: <u>12"</u>
PPE: <input checked="" type="checkbox"/> Cotton underwear	Prohibited Approach Boundary: <u>1"</u>
<input type="checkbox"/> FR shirt and pants (or FR coverall)	PPE: <input checked="" type="checkbox"/> Class 00
<input type="checkbox"/> Full flash suit and hood	<input checked="" type="checkbox"/> V-Rating 500
<input type="checkbox"/> Hard hat	<input type="checkbox"/>
<input checked="" type="checkbox"/> Safety glasses or goggles	
<input checked="" type="checkbox"/> Hearing protection	
<input type="checkbox"/> Leather gloves and shoes	
<input checked="" type="checkbox"/> Non melting shirt and pants	

Equipment ID: DISCONNECT MUNTERS M17 PARTICLE COUNTER



WARNING

Arc Flash and Shock Hazard Appropriate PPE Required

15' - 10" 133.7 Extreme Danger	Flash Hazard Boundary cal/cm2 Flash Hazard at 18 Inches PPE Level Dangerous work hazard; Energized work prohibited.
13.8 5' - 0" 2' - 2" 0' - 7"	kV Shock Hazard when cover is removed Limited Approach Restricted Approach - Class 2 Voltage Gloves Prohibited Approach - Class 2 Voltage Gloves

Equipment Name: MAIN SWG (Fed by: R-4)

ELECTRICAL ARC FLASH HAZARD

Arc Flash Boundary:

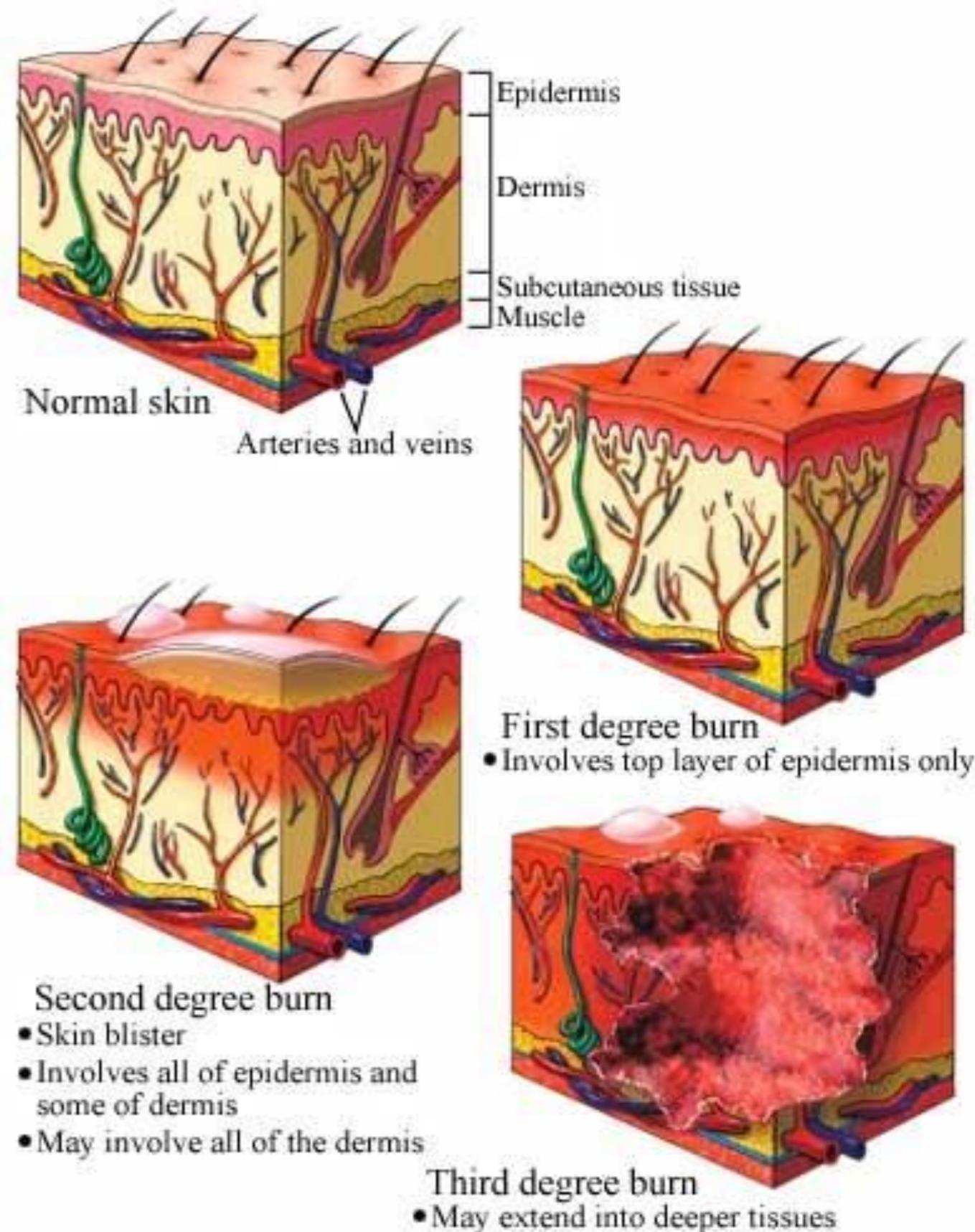
- Designed to prevent 2nd degree burns when unprotected during an arc flash.
- The higher the arc flash energy the greater the boundary.
- If inside the boundary PPE protection is needed to prevent injury.



STOLL EXPERIMENT

Stoll A.M., Greene L.C.,
"Relationship Between Pain and
Tissue Damage Due to Thermal
Radiation", Journal of Applied
Physiology 14: 373-382, 1959

- Based on experiments on humans.
- Used a flame source with varying times of exposure
- The time and energy was varied to determine a second degree burn threshold relationship.



ELECTRICAL ARC FLASH BOUNDARIES

NFPA Annex D:

Multiple Methods

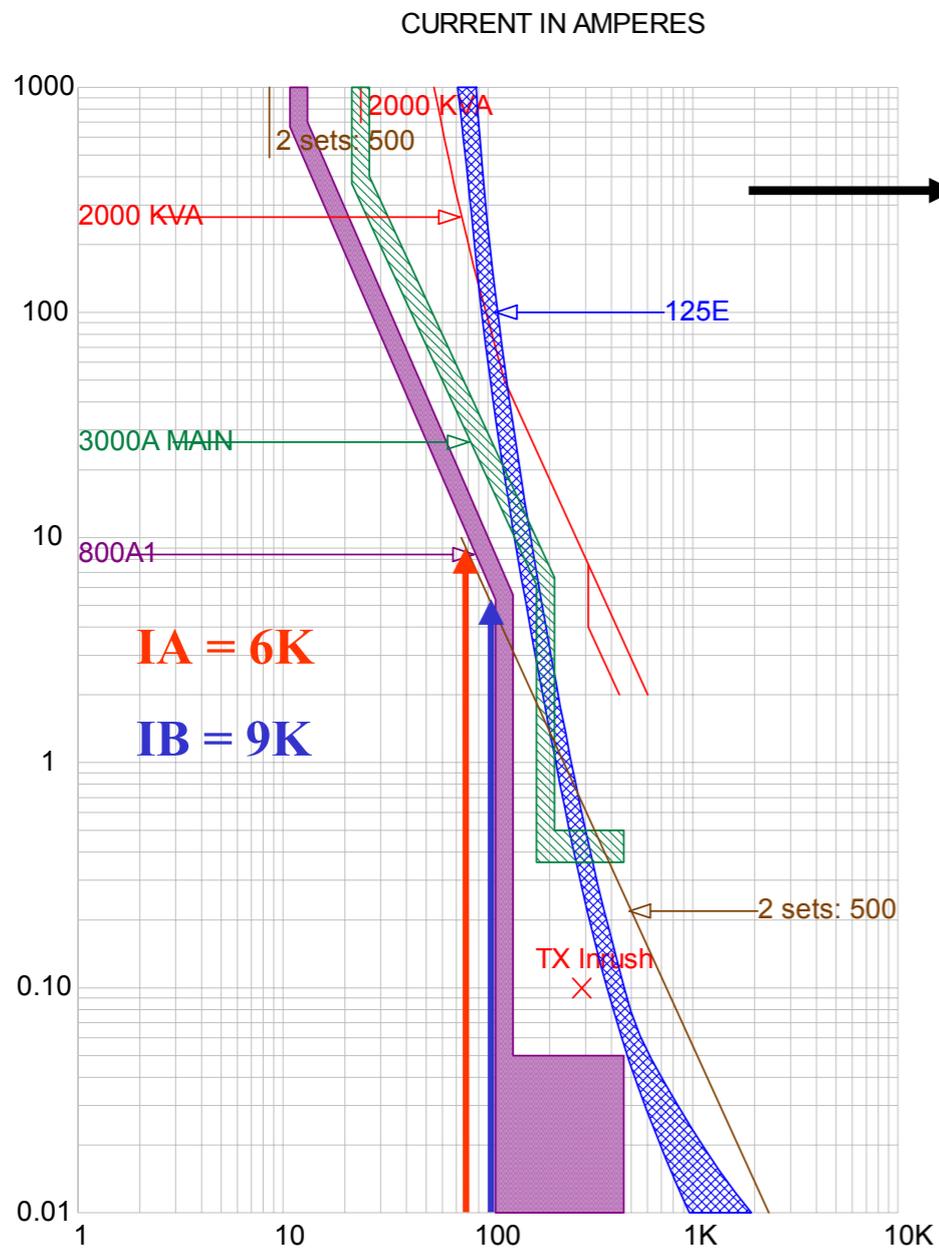
- Lee Method
- IEEE 1584 Method
- Software Solutions

Requires a complete protection coordination study

Important Factors:

- Available fault current
- Transformer kVA
- Transformer Impedance
- Motor Contribution
- Fuse or Breaker Curves and Settings
- Conduit Type

BREAKER/FUSE CURVES



Fault clears in 8 seconds

Incident energy = 718 cal/cm²

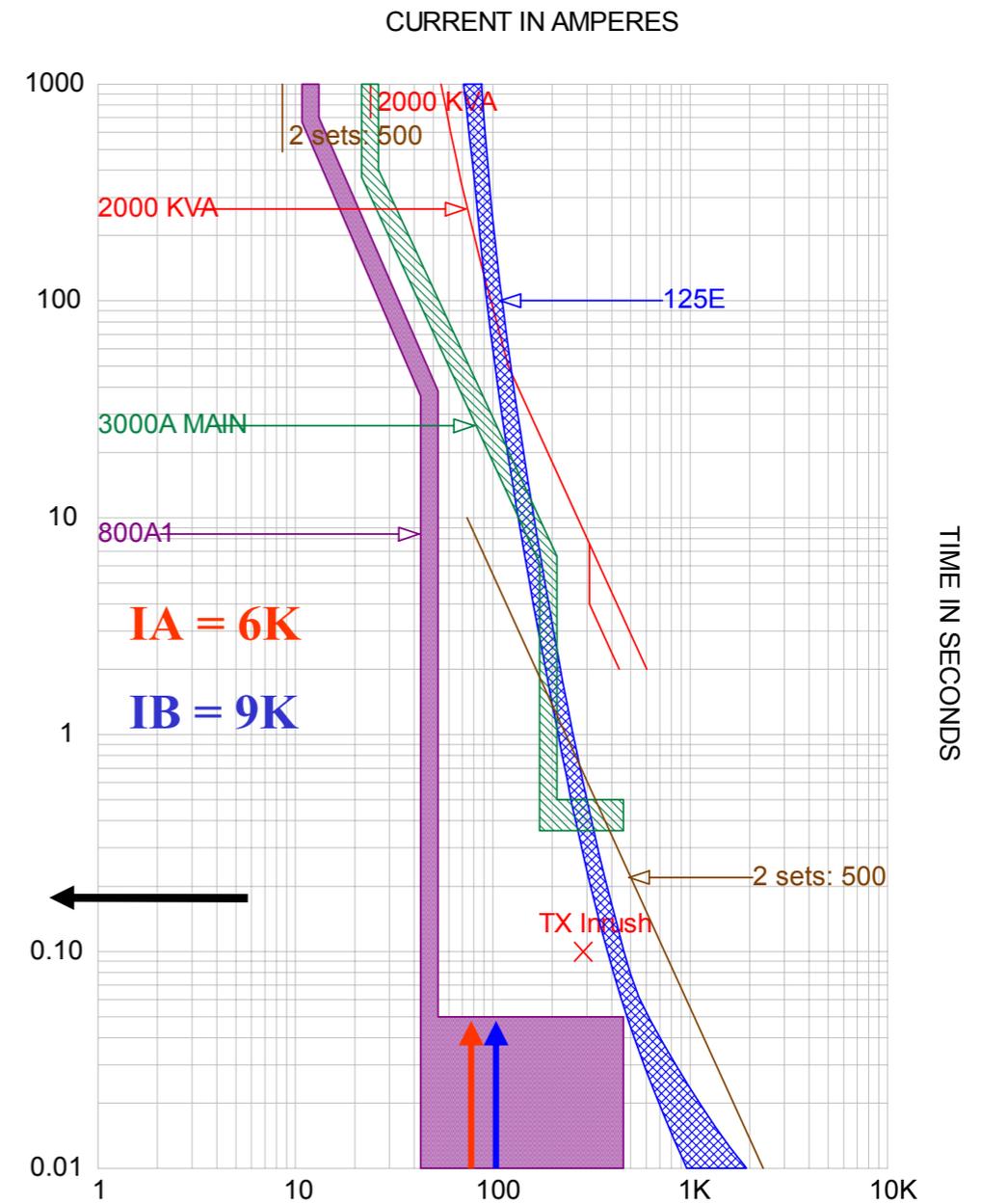
No FR class for IE values this high

Fault clears in 0.1 second

Incident energy = .97 cal/cm²

FR class 0

Case 3.tcc Ref. Voltage: 480 Current Scale x10² Ford Sharonville.drw



Case 3.tcc Ref. Voltage: 480 Current Scale x10² Ford Sharonville.drw

ELECTRICAL ARC FLASH HAZARD

- Arc Flash Hazard Analysis Results:
- PPE Selection
- Arc Flash Boundary



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<input type="checkbox"/> Full flash suit and hood	<input checked="" type="checkbox"/> V-Rating 500
<input type="checkbox"/> Hard hat	<input type="checkbox"/>
<input checked="" type="checkbox"/> Safety glasses or goggles	
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Equipment ID: DISCONNECT MUNTERS M17 PARTICLE COUNTER



WARNING

Arc Flash and Shock Hazard Appropriate PPE Required

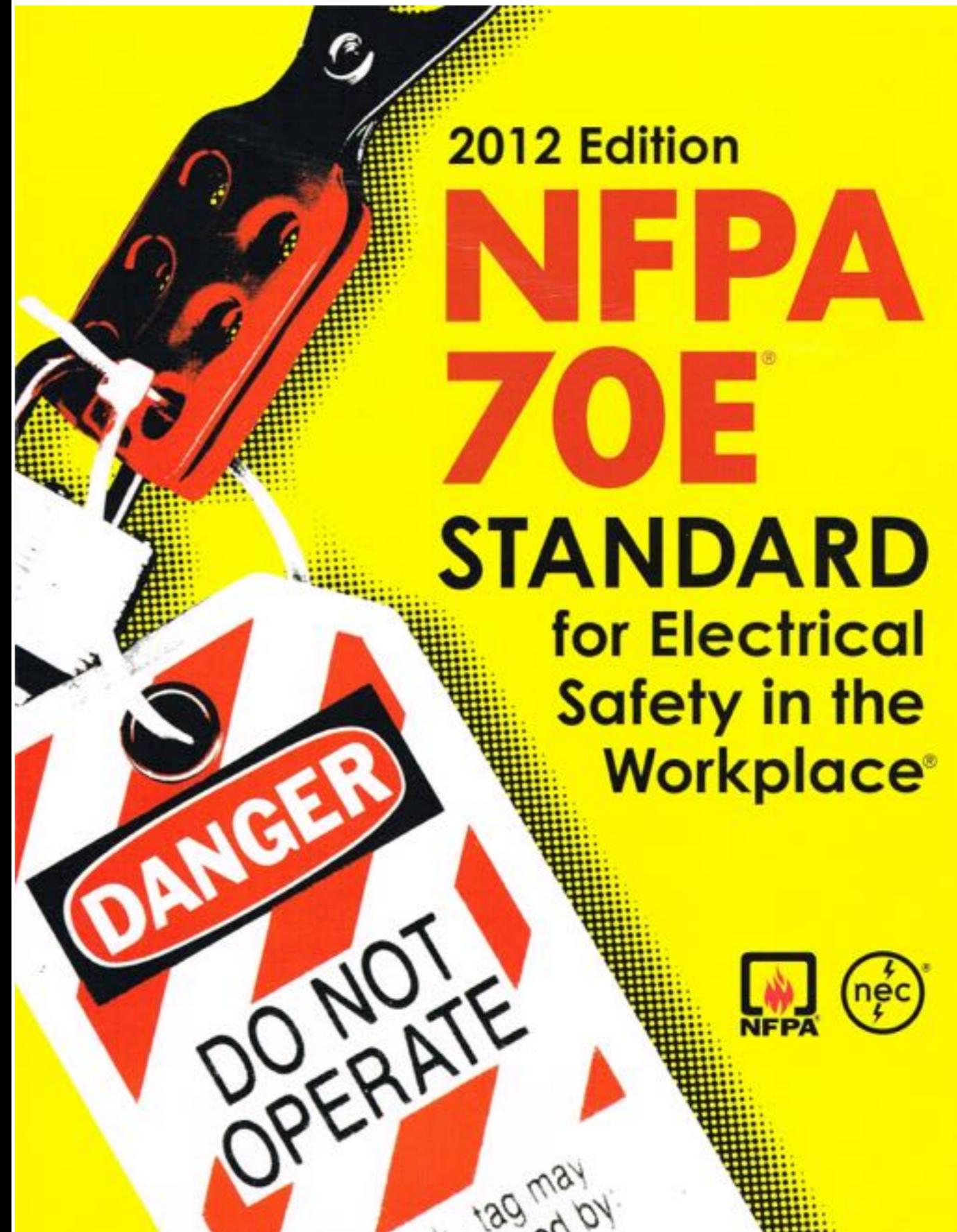
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Equipment Name: MAIN SWG (Fed by: R-4)

- “What is an electrical arc flash?”
- “How do I calculate the danger posed by an arc flash?”
- “How do I protect myself and others from an arc flash?”

ELECTRICAL SHOCK HAZARD

- Shock Hazard Analysis: A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and personal protective equipment necessary in order to minimize the possibility of electrical shock.
- Calculations based on NFPA 130.2



ELECTRICAL SHOCK HAZARD

- Shock Hazard Analysis Results:
- PPE Selection
- Approach Boundary



WARNING

Arc Flash & Shock Hazard Appropriate PPE Required

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PPE: <input checked="" type="checkbox"/> Cotton underwear <input type="checkbox"/> FR shirt and pants (or FR coverall) <input type="checkbox"/> Full flash suit and hood <input type="checkbox"/> Hard hat <input checked="" type="checkbox"/> Safety glasses or goggles <input checked="" type="checkbox"/> Hearing protection <input type="checkbox"/> Leather gloves and shoes <input checked="" type="checkbox"/> Non melting shirt and pants	Limited Approach Boundary: <u>42"</u> Restricted Approach Boundary: <u>12"</u> Prohibited Approach Boundary: <u>1"</u> PPE: <input checked="" type="checkbox"/> Class 00 <input checked="" type="checkbox"/> V-Rating 500 <input type="checkbox"/>

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Equipment Name: MAIN SWG (Fed by: R-4)

ELECTRICAL PPE

- PPE Selection:
- Based on Arc Flash and Shock Hazard
- FR, Fire Retardant clothing or Arc Flash Suit
- Arc Flash Suit:
- A complete FR clothing and equipment that covers the entire body, except for the hands and feet. This includes pants, jacket, and a beekeeper-type hood fitted with a face shield



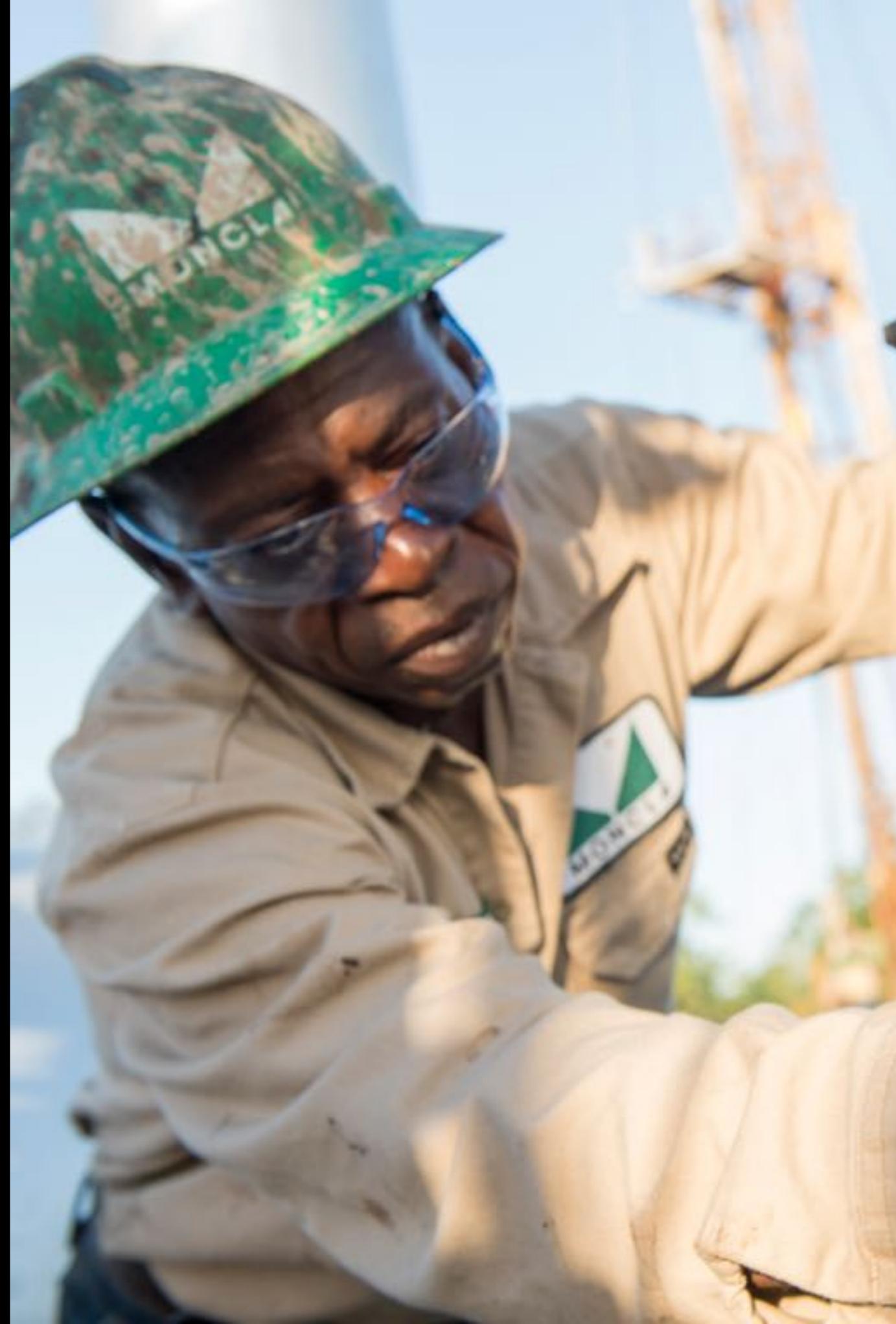
ELECTRICAL PPE

- Arc Rating: The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in $[\text{cal}/\text{cm}^2]$ and is derived from the determined value of the arc thermal performance value (ATPV) or energy breakopen threshold.



ELECTRICAL PPE

- 130.7(C)(10): Category 0
- Incident Energy: {0-1.2} [cal/cm²]
- Shirt (Long Sleeve) *1
- Pants (Long) *1
- Safety Glasses or Goggles
- Hearing Protection
- Gloves (As needed)
- *1: Non-melting (according to ASTM F 1506-00) or Untreated Natural Fiber



ELECTRICAL PPE

- 130.7(C)(10): Category 1
- Incident Energy: {1.2-4} [cal/cm²]
- Arc-rated long sleeve shirt
- Arc-rated pants
- Arc-rated coverall
- Arc-rated jacket, parka, or rainwear
- Hardhat, Safety Glasses, Hearing Protection
- Leather Gloves
- Leather work shoes



ELECTRICAL PPE

- 130.7(C)(10): Category 2
- Incident Energy: {4-8} [cal/cm²]
- Arc-rated long sleeve shirt
- Arc-rated pants
- Arc-rated coverall
- Arc-rated jacket, parka, or rainwear
- Hardhat, Safety Glasses, Hearing Protection
- Leather Gloves
- Leather work shoes
- Arc-rated flash suit hood, for Cat 2*



ELECTRICAL PPE

- 130.7(C)(10): Category 3
- Incident Energy: {8-25} [cal/cm²]
- Arc-rated long sleeve shirt
- Arc-rated pants
- Arc-rated coverall
- Arc-rated flash suit jacket, pants, hood
- Arc-rated jacket, parka, or rainwear
- Hardhat with FR lines, Safety Glasses, Hearing Protection
- Arc-rated Gloves
- Leather work shoes



ELECTRICAL PPE

- 130.7(C)(10): Category 4
- Incident Energy: {25-40} [cal/cm²]
- Arc-rated long sleeve shirt
- Arc-rated pants
- Arc-rated coverall
- Arc-rated flash suit jacket, pants, hood
- Arc-rated jacket, parka, or rainwear
- Hardhat with FR lines, Safety Glasses, Hearing Protection
- Arc-rated Gloves
- Leather work shoes



ELECTRICAL HAZARD ANALYSIS

- Approach Boundaries
- Shock
- From Shock Hazard Analysis
- Arc Flash
- From Arc Flash Hazard Analysis


WARNING

Arc Flash & Shock Hazard Appropriate PPE Required

FLASH PROTECTION	SHOCK PROTECTION
Flash Hazard Category: <u>0</u> Min. Arc Rating (cal/cm2): <u>0.96</u> Flash Protection Boundary: <u>11"</u>	480 VAC Shock Hazard When: COVER IS OPENED OR REMOVED
PPE: <input checked="" type="checkbox"/> Cotton underwear <input type="checkbox"/> FR shirt and pants (or FR coverall) <input type="checkbox"/> Full flash suit and hood <input type="checkbox"/> Hard hat <input checked="" type="checkbox"/> Safety glasses or goggles <input checked="" type="checkbox"/> Hearing protection <input type="checkbox"/> Leather gloves and shoes <input checked="" type="checkbox"/> Non melting shirt and pants	Limited Approach Boundary: <u>42"</u> Restricted Approach Boundary: <u>12"</u> Prohibited Approach Boundary: <u>1"</u> PPE: <input checked="" type="checkbox"/> Class 00 <input checked="" type="checkbox"/> V-Rating 500 <input type="checkbox"/>

Equipment ID: DISCONNECT MUTERS M17 PARTICLE COUNTER


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Equipment Name: MAIN SWG (Fed by: R-4)

ELECTRICAL HAZARD ANALYSIS

- Arc Flash Protection Boundary: When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur.



ELECTRICAL HAZARD ANALYSIS

- 130.7(C)(1) When an employee is working within the Arc Flash Protection Boundary he or she shall wear protective clothing and other personal protective equipment in accordance with 130.3.



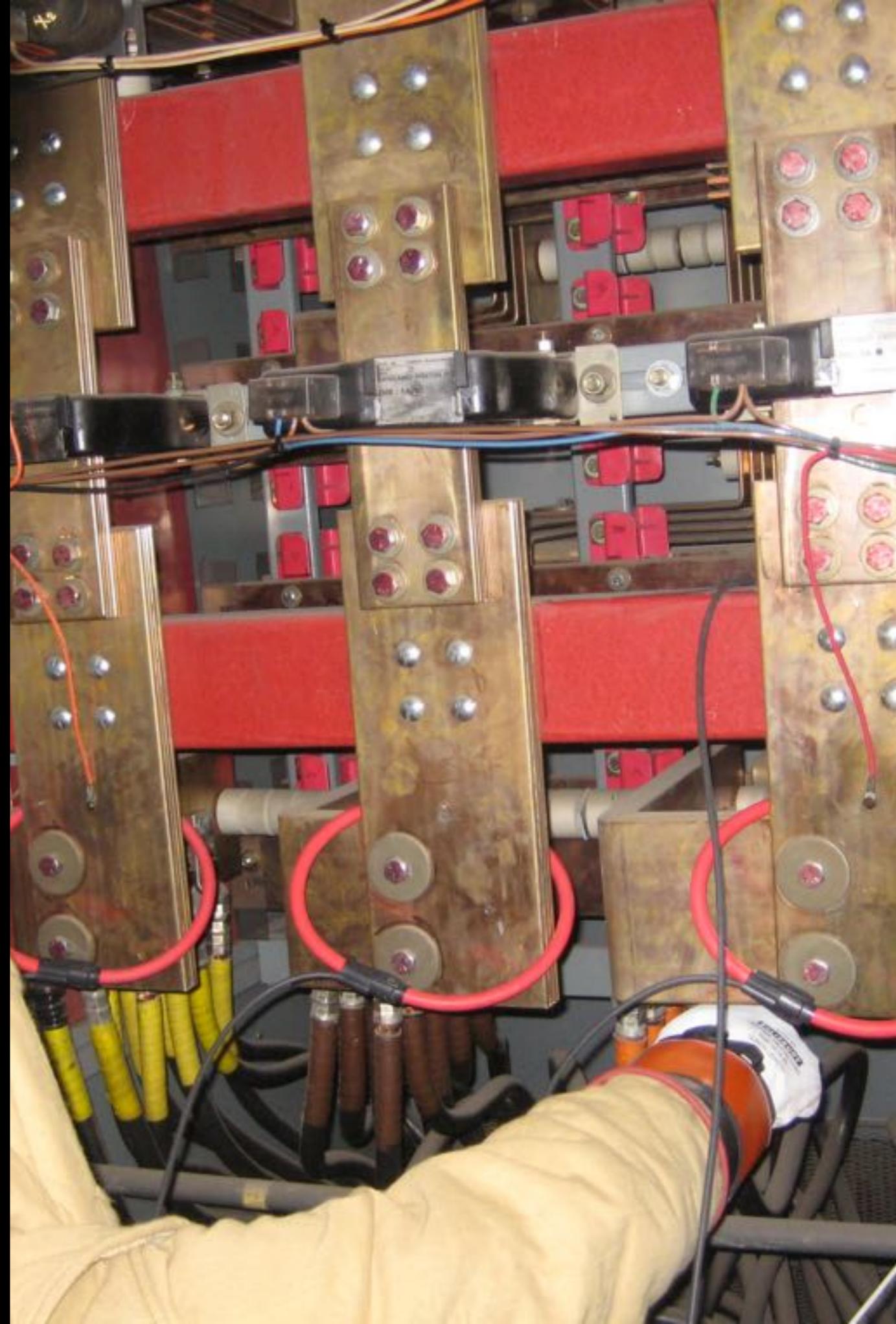
ELECTRICAL HAZARD ANALYSIS

- NFPA 70E defines an unqualified person as simply "a person who is not a qualified person." There are two kinds of unqualified persons:
- An unqualified electrician who does not know the equipment or has not received safety training on the potential hazards involved.
- A non-electrician, such as a general maintenance worker or painter, who is not expected to work on live electrical equipment.



ELECTRICAL HAZARD ANALYSIS

- Shock Hazard Boundary:
- Limited Approach Boundary: An approach limit at a distance from and exposed energized electrical conductor or circuit part within which a shock hazard exists.



ELECTRICAL HAZARD ANALYSIS

- Shock Hazard Boundary:
- Restricted Approach Boundary: An approach limit at a distance from and exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.



ELECTRICAL HAZARD ANALYSIS

- Shock Hazard Boundary:
- Prohibited Approach Boundary: An approach limit at a distance from and exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part.



ELECTRICAL SHOCK BOUNDARIES

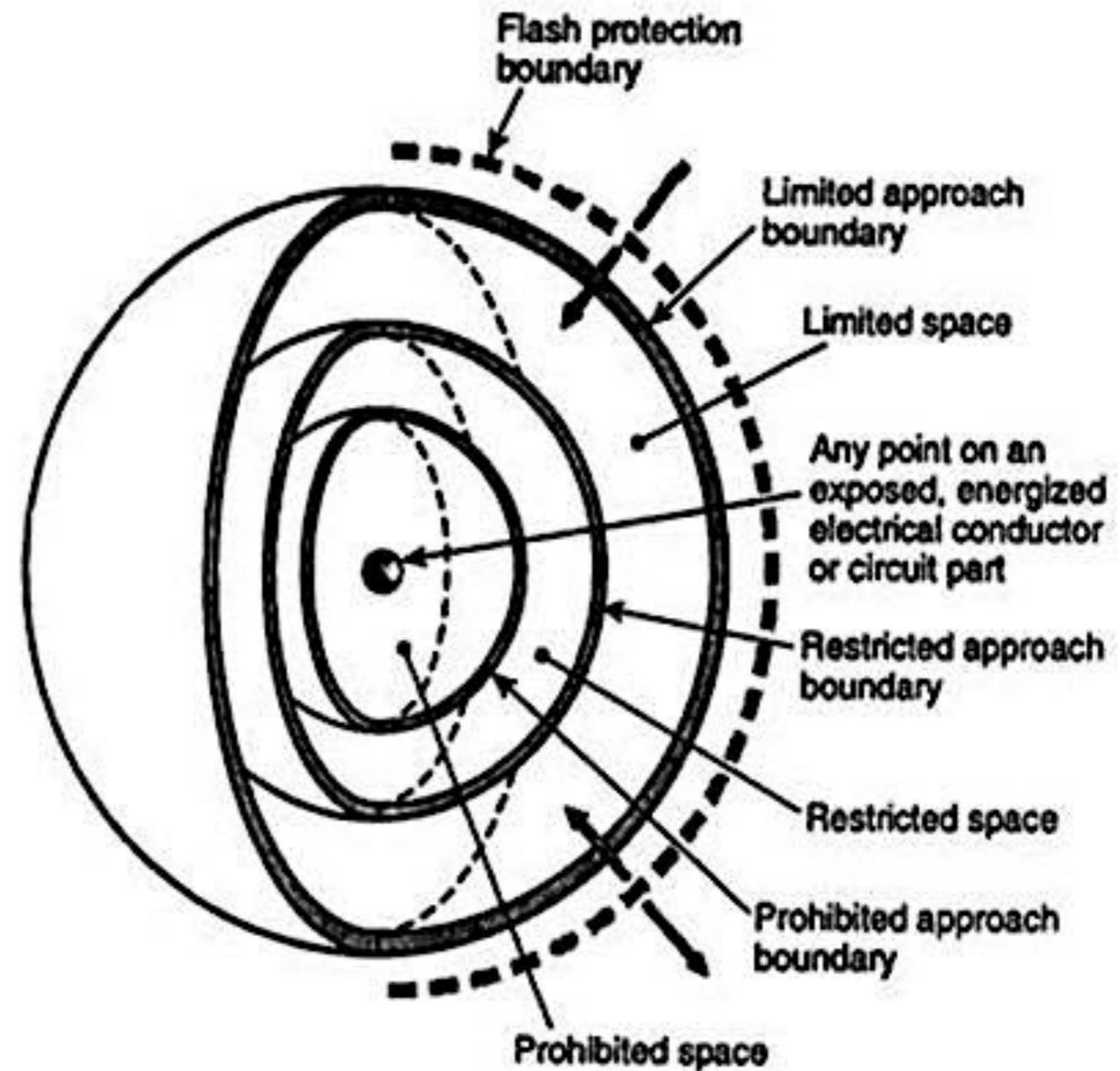
NFPA 70E Table 130.4 (C) (a)

Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection for Alternating Current Systems (all dimensions are distances from energized electrical conductor or circuit parts to employee)

(1)	(2)	(3)	(4)	(5)
<i>Limited Approach Boundary^b</i>				
<i>Nominal System Voltage Range, Phase to Phase⁴</i>	<i>Exposed Movable Conductor</i>	<i>Exposed Fixed Circuit Part</i>	<i>Restricted Approach Boundary^b; Includes Inadvertent Movement Adder</i>	<i>Prohibited Approach Boundary^b</i>
50 V	Not Specified	Not Specified	Not Specified	Not Specified
50 V – 300 V	3.0 m (10 ft. 0 in.)	1.0 m (3 ft. 6 in.)	Avoid Contact	Avoid Contact
301 V – 750 V	3.0 m (10 ft. 0 in.)	1.0 m (3 ft. 6 in.)	0.3 m (1 ft. 0 in.)	25 mm (0 ft. 1 in.)
751 V – 15 kV	3.0 m (10 ft. 0 in.)	1.5 m (5 ft. 0 in.)	0.7 m (2 ft. 2 in.)	0.2 m (0 ft. 7 in.)
15.1 kV – 36 kV	3.0 m (10 ft. 0 in.)	1.8 m (6 ft. 0 in.)	0.8 m (2 ft. 7 in.)	0.3 m (0 ft. 10 in.)
36.1 kV – 46 kV	3.0 m (10 ft. 0 in.)	2.5 m (8 ft. 0 in.)	0.8 m (2 ft. 9 in.)	0.4 m (1 ft. 5 in.)
46.1 kV – 72.5 kV	3.0 m (10 ft. 0 in.)	2.5 m (8 ft. 0 in.)	1.0 m (3 ft. 3 in.)	0.1 m (2 ft. 2 in.)
72.6 kV – 121 kV	3.3 m (10 ft. 8 in.)	2.5 m (8 ft. 0 in.)	1.0 m (3 ft. 4 in.)	0.8 m (2 ft. 9 in.)
138 kV – 145 kV	3.4 m (11 ft. 0 in.)	3.0 m (10 ft. 0 in.)	1.2 m (3 ft. 10 in.)	1.0 m (3 ft. 4 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.)	1.1 m (3 ft. 9 in.)
230 kV – 242 kV	4.0 m (13 ft. 0 in.)	4.0 m (13 ft. 0 in.)	1.3 m (4 ft. 3 in.)	1.6 m (5 ft. 2 in.)
345 kV – 363 kV	4.7 m (15 ft. 4 in.)	4.7 m (15 ft. 4 in.)	2.8 m (9 ft. 2 in.)	2.6 m (8 ft. 8 in.)
500 kV – 550 kV	5.8 m (19 ft. 0 in.)	5.8 m (19 ft. 0 in.)	3.6 m (11 ft. 10 in.)	3.5 m (11 ft. 4 in.)
765 kV – 800 kV	7.2 m (23 ft. 9 in.)	7.2 m (23 ft. 9 in.)	4.9 m (15 ft. 11 in.)	4.7 m (15 ft. 5 in.)

ELECTRICAL HAZARD BOUNDARIES

- Approach Boundaries
- Shock
- From Shock Hazard Analysis
- Calculations based on NFPA 130.2
- Arc Flash
- From Arc Flash Hazard Analysis
- Calculations based on NFPA Annex D



ELECTRICAL HAZARD BOUNDARIES

- 130.2(D)(1) Working at or close to the limited approach boundary: Where one or more unqualified persons are working at or close to the limited approach boundary, the designated person in charge of the work space where the electrical hazard exists shall advise the unqualified person(s) of the electrical hazard and warn them to stay outside of the limited approach boundary.



ELECTRICAL HAZARD BOUNDARIES

- 130.2(D)(2) Entering the limited approach boundary: Where there is a need for an unqualified person(s) to cross the limited approach boundary, a qualified person shall advise them of the possible hazards and continuously escort the unqualified person(s) while inside the limited approach boundary. Under no circumstances should the unqualified person(s) be allowed to cross the restricted approach boundary.



- “What is an electrical arc flash?”
- “How do I calculate the danger posed by an arc flash?”
- “How do I protect myself and others from an arc flash?”

HAZARD RISK CATEGORY CLASSIFICATIONS

- What if the hazard analysis process has not been completed?
- You can use the Hazard Risk Category Classifications 130.7(C)(9)



HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panelboards or Other Equipment Rated 240 V and Below- Note 1			
Perform infrared thermography & other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
Circuit breaker (CB) or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/Install CBs of fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panelboards or Switchboards Rated 240 V and up to 600 V (with molded case or insulated case circuit breakers) - Note 1			
Perform infrared thermography & other non-contact inspections outside the restricted approach boundary	1	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
Circuit breaker (CB) or fused switch operation with covers off	1	Y	Y
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	2	Y	Y

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
600 V Class Motor Control Center (MCCs) - Note 2			
Perform infrared thermography & other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V or below, exposed	2	Y	Y
Insertion or removal of individual starter “buckets” from MCC- Note 3	4	Y	N
Application of safety grounds, after voltage test	2	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)- Note 3	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) - Note 3	1	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2	Y	Y

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
600V Class Switchgear (with power circuit breakers or fused switches) - Note 4			
Perform infrared thermography & other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	2	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Other 600 V Class (277 V through 600, nominal) Equipment - Note 2 (except as indicated) Lighting or small power transformers (600 V Maximum)			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of safety grounds, after voltage test	2	Y	N
Revenue Meters (kW-hour at primary voltage and current) insertion or removal	2	Y	N
Cable trough or tray cover removal or installation	1	N	N
Misc Equipment Cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2	Y	Y
Application of safety grounds, after voltage test	2	Y	N
Insertion or removal of plug in devices into or from busways	2	Y	N

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
NEMA E2 (Fused contractor) Motor Starters, 2.3 kV through 7.2 kV			
Perform infrared thermography & other non-contact inspections outside the restricted approach boundary	3	N	N
Contractor operation with enclosure	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contractor operation with enclosure door open	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	3	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7 doors closed only	0	N	N

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Metal Clad Switchgear, 1 kV through 38 kV			
Perform infrared thermography & other non-contact inspections outside the restricted approach boundary	3	N	N
CB Operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB Or fused switch or starter operation with enclosure doors open	4	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V or below, exposed Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
ARC Resistant Switchgear Type 1 or 2 (for clearing times of <.05 with a perspective fault current not to exceed the Arc resistant rating of the equipment)			
CB operation with enclosure doors closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors open or closed	0	N	N
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or off the bus door closed	0	N	N

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Other Equipment 1kV Through 38 kV Metal-enclosed interrupter switch gear, fused or unfused			
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only Switch operation, doors closed	0	N	N
Switch operation, doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hook stick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in man hole or other confined spaces	4	Y	N
Insulated cable examination, in open area	2	Y	N

HAZARD RISK CATEGORY CLASSIFICATIONS

Table 130.7(C)(9):

Notes
a) Rubber insulating gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM zg 1505. Standard Specification for Insulated Hand Tools.
(c) Y = yes (required), N = no (not required)
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.
Specific Notes (as referenced in the table):
1. Maximum of 25 kA short circuit current available ; maximum of 0.03 sec (2 cycle) fault clearing time.
2. Maximum of 65 kA short circuit current available ; maximum of 0.33 sec (2 cycle) fault clearing time.
3. Maximum of 42 kA short circuit current available ; maximum of 0.33 sec (20 cycle) fault clearing time.
4. Maximum of 25 kA short circuit current available ; maximum of up to 0.5 sec (30 cycle) fault clearing time.

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