
Arc Flash Hazards in Plants – What are Arc Flash Hazards, How to Determine Arc Flash Hazards in Plants, and How to Protect Plant Staff

WWOA October 21, 2010

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Arc Flash Hazards Outline

✦ What are Arc Flash Hazards

- Approach Boundaries from Live Parts
- Hazard/Risk Categories

✦ How to Determine Arc Flash Hazards

- Calculating Arc Flash Hazards

✦ How to Protect Plant Staff

- Arc Flash Labels on Equipment
- Personal Protective Equipment (PPE)

✦ Typical Hazard/Risk Category Classifications at Plants

What are Arc Flash Hazards

- ◆ An arc flash occurs when there is a short circuit or failure of electrical equipment
 - ◆ A wire shorts to another wire or to ground
 - ◆ Wires or current carrying parts are bridged by a tool
- ◆ Results in a short circuit and arcing fault
 - ◆ Arc, explosion, ball of fire, cloud of hot molten metal, and pressure wave
- ◆ An unprotected person within the arc flash boundary
 - Second/third degree burns, blindness, hearing loss, concussion, and internal injuries

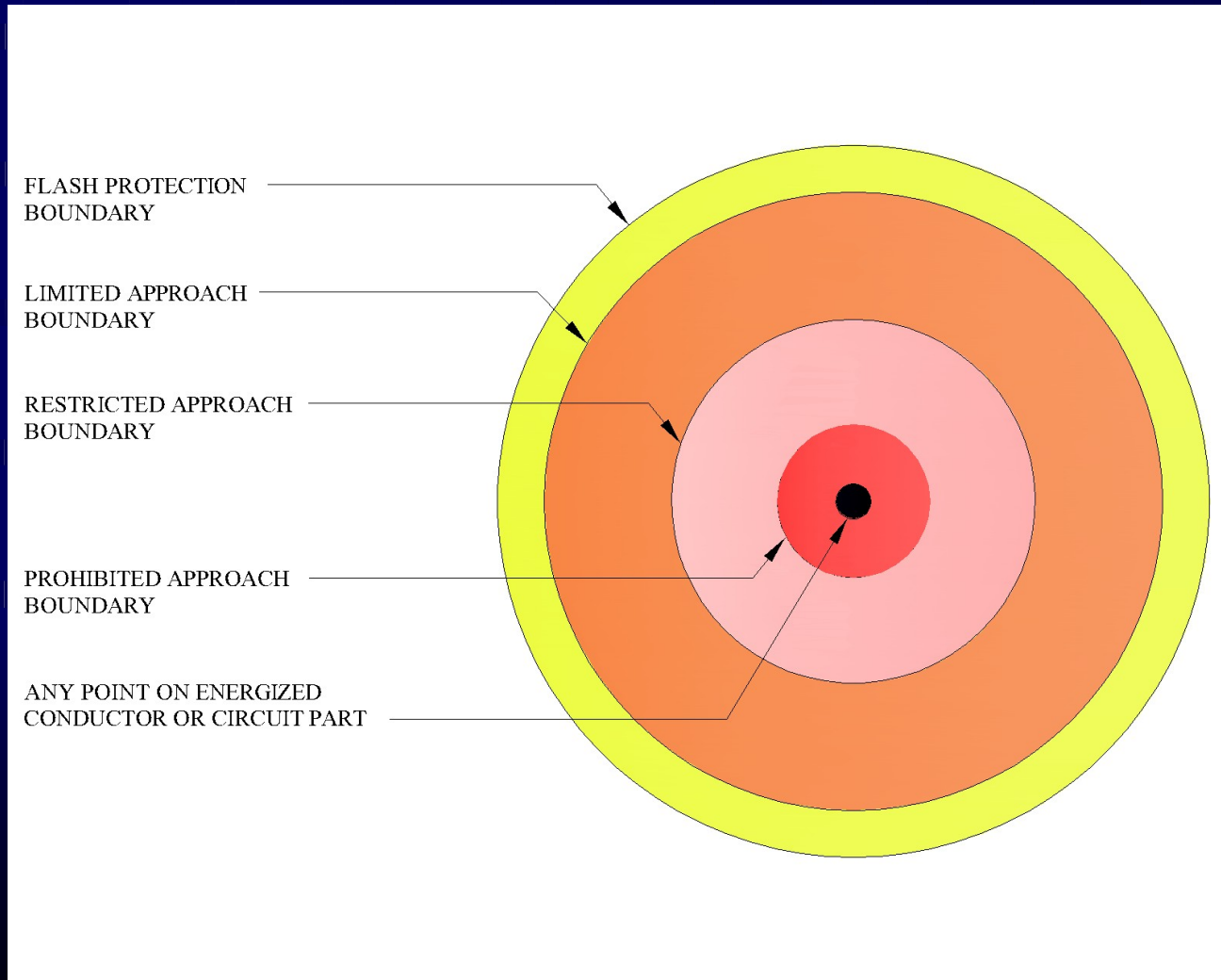
Arc Flash Hazard



How to Determine Arc Flash Hazards

- ◆ Arc flash hazard at each piece of equipment can be calculated
 - Amount of incident energy is calculated
 - Measured in joules/cm² (cal/cm²)
- ◆ Approach Boundaries from Live Parts
 - ◆ The distance from live parts that the hazards exist

Approach Boundaries from Live Parts



Approach Boundaries

- ◆ *Flash Protection Boundary* - Distance from exposed live parts within which a person could receive second degree burns if an arc flash occurred. Arc flash protection required within the flash boundary.
- ◆ *Limited Approach Boundary* - Distance from exposed live parts within which a shock hazard exists. Only a qualified person should cross the limited approach distance.
- ◆ *Restricted Approach Boundary* -Distance from exposed live parts within which only a qualified person using shock protection techniques and equipment for protection from shock should enter.
- ◆ *Prohibited Approach Boundary* -Distance from exposed live parts within which work is considered the same as making contact with the live part.

Hazard/Risk Categories

Table 130.7(C)(11) NFPA 70E. Protective Clothing Characteristics

Typical Protective Clothing Systems		
Hazard/Risk Category	Clothing Description	Required Minimum Arc Rating of PPE Joules/cm ² (cal/cm ²)
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd ²	N/A
1	Arc-rated FR shirt and FR pants or FR coveralls	16.74 (4)
2	Arc-rated FR shirt and FR pants or FR coveralls	33.47 (8)
3	Arc-rated FR shirt and FR pants or FR coveralls, And arc flash suit selected so that the system arc rating meets the required minimum	104.6 (25)
4	Arc-rated FR shirt and FR pants or FR coveralls, And arc flash suit selected so that the system arc rating meets the required minimum	167.36 (40)


Arc Flash Hazard Calculations

- ✦ To determine the amount of incident energy available and the hazard/risk category for each piece of equipment, an arc flash study is required.
 - ✦ Based on the available short circuit current at the equipment (short circuit study)
 - ✦ Based on how fast the overcurrent protective device (circuit breaker, fuse, or protective relay) can open and eliminate the short circuit. (coordination study)
- ✦ Therefore, a short circuit study and coordination study must first be performed at the facility before the arc flash hazard study


Arc Flash Labels

- ✦ Each piece of electrical equipment is required to have an arc flash label defining the arc flash hazard and the required personal protective equipment (PPE)
 - ✦ Arc Flash labels required by National Electrical Code (NEC), NFPA 70.


Example Arc Flash Label

 WARNING	
Arc Flash and Shock Hazard	
Appropriate PPE Required	
12 inches	Flash Hazard Boundary
0.58 cal/cm²	Flash Hazard at 18 inches
Category 0	Untreated Cotton
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inches	Limited Approach
12 inches	Restricted Approach
1 inches	Prohibited Approach
Location:	PRI T2
Prepared on: 11/26/2008	

Example Arc Flash Label

 WARNING	
Arc Flash and Shock Hazard	
Appropriate PPE Required	
31 inches	Flash Hazard Boundary
3.0 cal/cm²	Flash Hazard at 18 inches
Category 1	FR Shirt & Pants
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inches	Limited Approach
12 inches	Restricted Approach
1 inches	Prohibited Approach
Location:	30-MCC-1
Prepared on: 11/26/2008	

Example Arc Flash Label

 WARNING	
Arc Flash and Shock Hazard	
Appropriate PPE Required	
40 inches	Flash Hazard Boundary
4.4 cal/cm²	Flash Hazard at 18 inches
Category 2	Cotton Underwear + FR Shirt & Pants
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inches	Limited Approach
12 inches	Restricted Approach
1 inches	Prohibited Approach
Location:	Incoming line 20-MCC-1
Prepared on:	11/26/2008

Personal Protective Equipment

Table 130.7(C)(10) NFPA 70E Protective Clothing and Personal Protective Equipment

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 0	
Protective Clothing, Nonmelting or Untreated Natural Fiber FR Protective Equipment	Shirt (long sleeve) Pants (long) Safety glasses or safety goggles Hearing protection (ear canal inserts) Leather gloves
Hazard/Risk Category 1	
FR Clothing, Minimum Arc Rating of 4 cal/cm ² FR Protective Equipment	Arc-rated long sleeve shirt Arc-rated pants Or Arc-rated coverall Arc-rated face shield or arc flash suit hood Arc-rated jacket, parka, or rainwear (as needed) Hard hat Safety glasses or safety goggles Hearing protection (ear canal inserts) Leather gloves Leather work shoes

Personal Protective Equipment

Table 130.7(C)(10) NFPA 70E Protective Clothing and Personal Protective Equipment

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 2	
<p>FR Clothing, Minimum Arc Rating of 8 cal/cm²</p> <p>FR Protective Equipment</p>	<p>Arc-rated long sleeve shirt Arc-rated pants Or Arc-rated coverall Arc-rated face shield or arc flash suit hood Arc-rated jacket, parka, or rainwear (as needed)</p> <p>Hard hat Safety glasses or safety goggles Hearing protection (ear canal inserts) Leather gloves Leather work shoes</p>
Hazard/Risk Category 2 *	
<p>FR Clothing, Minimum Arc Rating of 8 cal/cm²</p> <p>FR Protective Equipment</p>	<p>Arc-rated long sleeve shirt Arc-rated pants Or Arc-rated coverall Arc-rated arc flash suit hood Arc-rated jacket, parka, or rainwear (as needed)</p> <p>Hard hat Safety glasses or safety goggles Hearing protection (ear canal inserts) Leather gloves Leather work shoes</p>

Personal Protective Equipment

Hazard/Risk Category 3	
FR Clothing, Minimum Arc Rating of 25 cal/cm ²	<ul style="list-style-type: none"> Arc-rated long sleeve shirt Arc-rated pants Or Arc-rated coverall Arc-rated flash suit jacket Arc-rated flash pants Arc-rated arc flash suit hood Arc-rated jacket, parka, or rainwear (as needed)
FR Protective Equipment	<ul style="list-style-type: none"> Hard hat FR hard hat liner Safety glasses or safety goggles Hearing protection (ear canal inserts) Arc-rated gloves Leather work shoes
Hazard/Risk Category 4	
FR Clothing, Minimum Arc Rating of 40 cal/cm ²	<ul style="list-style-type: none"> Arc-rated long sleeve shirt Arc-rated pants Or Arc-rated coverall Arc-rated flash suit jacket Arc-rated flash pants Arc-rated arc flash suit hood Arc-rated jacket, parka, or rainwear (as needed)
FR Protective Equipment	<ul style="list-style-type: none"> Hard hat FR hard hat liner Safety glasses or safety goggles Hearing protection (ear canal inserts) Arc-rated gloves Leather work shoes

Personal Protective Equipment



Personal Protective Equipment



Personal Protective Equipment



ARC 15
Provides protection to
15 cal/cm², NFPA 70E
Hazard / Risk category 2



ARC 25
Provides protection to
29 cal/cm², NFPA 70E
Hazard / Risk category 3



ARC 40
Provides protection to
49 cal/cm², NFPA 70E
Hazard / Risk category 4



ARC 65
Provides protection to
70 cal/cm², NFPA 70E



ARC 100
Provides protection to
106 cal/cm², NFPA 70E

Examples

Table 130.7(C)(9) Partial Hazard/Risk Category Classifications, Article 130, NFPA 70E

Hazard/Risk Category Classifications

Task (Assumes Equipment is Energized and Work is Done within the Flash Protection Boundary)	Hazard/Risk Category	Voltage -Rated Gloves*	Voltage -Rated Tools**
Panelboards rated 240 V and Below¹			
Circuit breaker (CB) or fused switch operation w/covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers)¹			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2 [†]	Y	Y

Examples

Table 130.7(C)(9) Partial Hazard/Risk Category Classifications, Article 130, NFPA 70E

Hazard/Risk Category Classifications			
Task (Assumes Equipment is Energized and Work is Done within the Flash Protection Boundary)	Hazard/Risk Category	Voltage -Rated Gloves *	Voltage -Rated Tools **
600 V Class Motor Control Center (MCCs)²			
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 door open	1	N	N
Work on energized parts, including voltage testing	2 [†]	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2 [†]	Y	Y
Insertion and removal of individual starter “buckets” from MCC ³	3	Y	N
Application of safety grounds, after voltage testing	2 [†]	Y	N
Removal of bolted covers (to exposed bare, energized parts)	2 [†]	N	N
Opening hinged covers (to exposed bare, energized parts)	1	N	N

Questions?